Popular Astronomy.

Vol. XXXII, No. 4 APRIL, 1924 Whole No. 314

THE EXPEDITION FROM THE YERKES OBSERVATORY FOR OBSERVING THE TOTAL SOLAR ECLIPSE OF SEPTEMBER 10, 1923, AT CAMP WRIGLEY.

By EDWIN B. FROST.

It may seem superfluous to publish any extensive statement regarding an eclipse expedition which proved to be a total failure with respect to observations and photographs by reason of the completely cloudy sky, but it has been our experience that a tolerably complete record of the preparations is of much value to the members of the party in planning any future work along similar lines. It is hoped that this account may also be in some respects of interest to others who may be undertaking to observe a total eclipse for the first time.

It has not been the policy of the Yerkes Observatory to send eclipse expeditions outside of the United States, but it has seemed desirable and appropriate that total solar eclipses occurring within the country should be observed by a party when possible. The authorities of the University of Chicago have concurred in this view.

About three years ago we began to investigate the circumstances of the eclipse of 1923, and the sites available for its observation. The situation of the Island of San Clemente, about sixty miles from the coast, off Los Angeles, at first seemed rather favorable, as it was near the central line of the eclipse. Further investigation showed, however, that it would be both difficult and expensive to establish a station there, as the island is not inhabited and access is difficult. Accordingly, it seemed wise to sacrifice something in the duration of totality and choose a site on the Island of Santa Catalina, which is well known as an attractive pleasure resort for summer and winter, and has excellent facilities for transportation and for living.

An inquiry was first made as to the probability of favorable conditions of weather in September. Through the courtesy of Captain D. M. Renton, Vice-President and General Manager of the Santa Catalina Island Company, to whom we are indebted for his very kind coöperation in many ways, I was able to secure a record of the clearness of the sky twice a day from September 8 to 12, 1921. The conditions did not appear as favorable as could be expected, but this was due to the fact that the observations were made in the morning and evening, at sea level, when foggy conditions are very likely to prevail at that season. Accordingly, at my request, observations were made for the

first twenty days of September, 1922, at one o'clock, the hour of the eclipse, and a much more favorable record was obtained, sixteen days being clear at that hour, three cloudy, and one partially cloudy. An appreciable wind was recorded on only one day.

The percentage of clear days at eclipse time being eighty, and the duration of totality being 2 minutes 49 seconds, it seemed that the Island would offer a promising place for a station, particularly as an elevation could be reached which would probably be above the ordinary ocean fog. I approached Mr. William Wrigley, Jr., with the suggestion that he make a gift to the University of Chicago to cover the expense of an expedition to Santa Catalina Island, of which he had recently acquired the controlling interest under the name of the Santa Catalina Island Company. In September, 1922, he generously agreed to contribute $5,000 for this purpose, and thus made the expedition possible.

During subsequent months a study was made of the observations which should be undertaken by our party, and the following items were decided upon:

1. As at the eclipses of 1900 and 1918, a coelostat would be used with the 6-inch photographic telescope of 61½ feet focus for procuring photographs of the solar corona on a large scale, the telescope to be fed from our coelostat with an 11½-inch Brashear flat mirror. The lens gives a diameter of 7 inches to the solar image, the same as that of the 40-inch telescope, to which this lens is commonly attached as a long-focus finder. The operation of this instrument was entrusted to Assistant Professor Oliver J. Lee, and the program was planned to secure six exposures as follows:

1	second	on	14 x 17 in.	Seed 30
8	seconds	"	16 x 20 "	Cramer Iso.
120	"	"	20 x 24 "	Graflex
16	"	"	10 x 20 "	Seed 23
4	"	"	14 x 17 "	Seed 30
1	second	"	14 x 17 "	Seed 30
150				

As in previous operations of this instrument, the observer was to stand in the large dark room, twenty-six feet long, with the plates in position on a carriage which could be rapidly moved from right to left in passing from one exposure to the next. The shutter, which was sixty-feet away, in front of the 6-inch lens, was operated by a cord in the hand of the observer.

2. At the eclipse of 1918 I attempted to secure a cinematographic record of the flash spectrum at second and third contacts with a Universal moving picture camera placed behind a train of prisms with an appropriate lens for throwing the image upon the film. The cloud which partially obscured the sun on June 8, 1918, at Green River, Wyoming, of course prevented us from securing the fine detail of the

flash spectrum, although some two thousand impressions of the spectrum were obtained, covering the period of one minute before and one minute after second and third contacts. Our sidereal break-circuit chronometer was connected with a small electric lamp, so that a black dot would be impressed at every second on a corner of the picture, and thus give a record of the time at which the different exposures were made. It was planned to turn the camera so that there would be sixteen exposures to the second at the first flash, and eight to the second at the second flash. Three large Mantois prisms transmitting a beam of two inches aperture were to be again used, and the camera lens was a special one made some years ago by Brashear, having an aperture of 2 inches (51 mm.) and a focal length of 16 inches (406 mm.). The operation of this instrument was assigned to Mr. C. T. Elvey, Instructor in Astronomy at the University of Kansas, who spent the summer at the Yerkes Observatory in preparing this apparatus and several others for use at the eclipse.

3. Our attempt at the eclipse of 1918 to secure photographs of the flash spectrum in the extreme red having been foiled by the cloud, we planned to try this again in 1923. The optical part consisted of a small concave grating of 60-inches focus, mounted in a box and receiving light from a coelostat. No slit being employed, the image of the spectrum would be formed at a distance of 30 inches on a film bent to a radius of curvature of 15 inches. The operation of this instrument was undertaken by Professor Paul Biefeld of Denison University, Granville, Ohio, who had experimented with the apparatus previous to the eclipse, both at Denison and at the Yerkes Observatory, and had secured excellent definition on the trial films. The films were dyed with dicyanin. The coelostat which supplied the light for this instrument, as well as for the movie flash, was loaned by the United States Naval Observatory, through the kindness of the (then) superintendent, Captain W. D. MacDougall. It was transported on a government vessel with the apparatus of the party from the University of Virginia from Hampton Roads to San Pedro. The coat of silver of the 7-inch mirror was found to be in bad condition when we were able to examine it, and the mirror was re-silvered for us at the Mount Wilson Observatory laboratory through the kindness of Dr. Walter S. Adams. He also loaned to us a second mirror of 9 inches aperture which we attached to the same coelostat in place of the counterweight provided with it, and thus two beams were secured for the two pieces of spectroscopic apparatus. The position angles of the points of contact at first and second flash were rather unfavorable at our station, which was about twenty-eight miles from the central line of totality, being only 102° apart. The table carrying the spectroscopic apparatus, therefore, had to be placed at an angle of 46° below the horizontal for the first flash, and then tilted on pivots to an angle of 56° above the horizontal for the second flash. This was arranged by using as a bearing a large piece of pipe through which

the beam entered the apparatus, according to a plan suggested by Mr. Elvey.

4. At the eclipse of 1918, the 20-inch equatorial of the Chamberlin Observatory of the University of Denver had been very generously placed at our disposal by Director H. A. Howe. For use with this excellent instrument, I had adapted an auto-collimating spectrograph of 30 inches focus, carrying a Michelson grating which concentrated light to a considerable degree in the first order on one side. We planned to use the green coronal line at λ 5303 with isochromatic plates. An attachment of the Porter solar spectrograph of the Allegheny Observatory, kindly loaned by its former director, Professor F. Schlesinger, brought upon the slit light from any desired points east and west of the sun, so that an attempt could be made to measure the rotation of the corona from the relative displacement of the lines from two sides. The upper and lower parts of the slit were to receive light from one side of the inner corona—say, the western—while the central part was to receive light from the other side. The entirely cloudy condition at Denver at the eclipse of 1918 prevented us from getting any experience with this apparatus. Although the coronal radiation might be expected to be too feeble in 1923, occurring at sun-spot minimum, it nevertheless seemed worth while to try the experiment again with some modifications. Director H. D. Curtis of the Allegheny Observatory again kindly loaned the attachment employed before, which had been in use by Professor Philip Fox, of Northwestern University, Evanston, Illinois, for another purpose, both at the Yerkes and Dearborn observatories in 1922. As the loss of light in the grating would be too great, I ordered in the Spring from the Spencer Lens Company, Hamburg, New York, clear flint glass for a new prism. It was figured by MacDowell, and has an angle of 33° 28′, the perpendicular surface being silvered.

The tests of the prism were kindly made by Mr. Struve on our large spectrometer. It was not feasible to procure a new lens to serve for the collimator and camera, and the visually-corrected 3-inch lens by Petitdidier, previously used, was retained. It was thought best to center the spectrum for the coronal line at λ 4241, and the definition seemed also adequate for the use of the other coronal lines at λλ3987, 4086, 4231 and 4359.

This apparatus was put into preliminary adjustment by Mr. Elvey, and was then sent to Professor Fox at Evanston, who made many trial photographs with it before it was sent to Catalina. Mr. Fox undertook the operation of this instrument at the eclipse in addition to a program which he had arranged with his assistants, Messrs. Lloyd R. Wylie and H. B. Curtis, for the visual observation of the flash spectrum as given by two objective-prism spectroscopes.

5. Our plans included a repetition of the photometric work undertaken by Associate Professor J. A. Parkhurst at the eclipse of 1918, the equipment of which was all assembled in a separate hut with a re-

movable roof, and included the following instruments: The Zeiss doublet of 145 mm. aperture and 81 cm. focus, which is of U.-V. glass, was covered by its 30° objective prism of the same glass, the refracting edge being set east and west. On the other side of Mr. Parkhurst's equatorial mounting was attached in place of the counterweight his small Brashear reflector of 15 cm. aperture and 150 cm. focal length. Over this our U.-V. objective prism of 15° angle was placed with its refracting edge north and south. The Hartmann microphotometer was again set up on an altazimuth mounting for the visual observation of the total intensity of the coronal light in comparison with electric lamps which had been standardized by the Eastman Research Laboratory. With this instrument, the standard electric light is reduced by a photographic wedge to equality with direct light after passing through a blue filter made by the Palo Company. The visual observations with this instrument were to be made by Mr. Parkhurst with Robert Greenleaf as reader of the voltmeter and ammeter. The exposures with the objective prisms were made by Misses Anne Young and Alice Farnsworth of Mt. Holyoke College. Mrs. Parkhurst called the time in the hut, and Miss Helen Barrett removed the caps from the objective prisms. This photometric corps had its own rehearsals repeated many times well in advance of the day of the eclipse.

6. The interesting development of the visual pyrometer which has been made at the Nela Research Laboratory, Cleveland, chiefly by Dr. W. E. Forsythe, rendered it very desirable that the instrument should be used for the measurement of the color-temperature of the corona. In an article published in "Nature," Volume 112, page 533, in April, 1923, Dr. Forsythe gave his results of such measurements on the moon. At my request, Professor C. C. Crump of Ohio Wesleyan University undertook to make these observations, and he went to Cleveland shortly before the eclipse to practise in the use of the instrument with the kind assistance of Messrs. Forsythe and Worthing. The light from the electric lamps used for comparison had been calibrated at the Nela Laboratory, and two filters were used, one blue and another yellow. From the reading of the milli-ammeter, the amount of light could thus be accurately determined. Professor J. W. Campbell, of the University of Alberta at Edmonton, assisted Mr. Crump in recording observations and reading the milli-ammeter, which was kindly loaned to us by the American Telephone and Telegraph Company from its office at Los Angeles.* The pyrometer was mounted on a small altazimuth stand-

*For other observations with the optical pyrometer, reference may be made to the following articles:

"The Disappearing Filament Type of Optical Pyrometer," by W. E. Forsythe (a paper read before The Faraday Society, Monday, July 14, 1919).

"Color Temperature and Brightness of Various Illuminants," by Edward P. Hyde and W. E. Forsythe. (Reprint from the *Transactions of the Illuminating Engineering Society*, No. 8, 192.)

1919 Report of Standards Committee on Pyrometry, by W. E. Forsythe. (Re-

ard, and it was planned to observe the intensity of the coronal light both east and west of the sun at distances of ten and fifteen minutes of arc. Prior to the eclipse, observations of the intensity of the light of the sky were made on various occasions by Mr. Crump.

7. In regard to securing a record of the successive stages of the eclipse, a Universal motion picture camera was employed which was provided with a Hawkeye lens of about 3.2 inches aperture, 20 inches focus, and focal ratio of 6.3. This lens, made for aerial photography, was loaned to us by the Eastman Kodak Company through the kind offices of Mr. C. W. Frederick. A standard lamp was provided to give a small dot in one corner of each "frame" so that the film could be used for photometric purposes. An iris diaphragm was placed over the lens to reduce the aperture during the partial phase when it was difficult to avoid over-exposure. A filter was also necessary to reduce the intensity at this time. This camera was attached to an equatorial mounting carrying a 4-inch Brashear telescope of 60 inches focus, loaned us by Dr. George S. Isham of Chicago, to whom we are also indebted for the loan of the movie camera.

The schedule of exposures was planned to include an excursion with the slow motions so that the planet Venus could be shown on the film during part of totality. The telescope was operated by Professor Harriet W. Bigelow of Smith College, who was also to get visual observations of the inner corona while guiding. The exposures with the camera were to be made by Mr. Warren Gorrell, a student at Amherst College. The standard lamp was fed by a current from a storage battery. It was planned to use about two hundred feet of film with this instrument, one turn to be given at intervals of five minutes during the early stages of the partial phase, and these exposures were to be made more frequently as totality approached.

8. The low equatorial mounting of the sky patrol was transported from the Yerkes Observatory and set up on posts to carry the following cameras:

(a) The Apochromatic Planar of 51 mm. aperture, and 315 mm. focus, with which one long exposure was to be made on an autochrome plate to be developed by Professor Biefeld who has had much experience in color photography.

(b) The Tessar of aperture 2⅝ inches (67 mm.), focal length 302 mm., also used on the sky patrol, covered by an objective prism of 58° angle with the refracting edge east and west.

(c) The Clark photographic doublet of 3.4 in. aperture (86 mm.), and about 20 in. focus was attached to this mounting to furnish a long

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print from *The Journal of the Optical Society of America*, Vol. III, No. 5, September 1920, pp. 305-36.)

"A Morse Optical Pyrometer Adapted to a Wide Range of Laboratory Uses," by W. E. Forsythe. (*The Astrophysical Journal*, Vol. XLIII, No. 4, May 1916.)

Technologic Papers of the Bureau of Standards, No. 170 Pyrometric Practice.

exposure on the stars or any other objects in the vicinity of the sun.

The exposures of these three lenses were to be made by Professors I. Yamamoto of Kyoto University, and E. W. Bryant of Middlebury College, Vermont.

9. The attempt to secure a good record of the eclipse on films which could be used for educational purposes, as well as for general exhibition to the public, was arranged in coöperation with Captain B. W. Harris of Chicago, who has had much experience in the use of the movie camera for scientific purposes. He was designated the official photographer of our camp, and was to have the opportunity to recompense himself for his heavy expenses by the sale of his film, copies of all of which were to be supplied to us gratuitously. "Captain Harris's Battery" consisted of four special lenses loaned by the Air Service of the War Department from the government supply at Dayton, Ohio. He also had four large Universal cameras also loaned by the War Department. Two of these lenses were of 70 mm. focus (27.6 inches) with a focal ratio of 5, and the other two were of focal length 500 mm. (19.7 inches), and the ratios of 4.8 and 4.5 respectively. Two of the cameras intended for securing partial phases as well as totality were driven on the equatorial mounting by an electric motor; the other two to be operated during totality did not require such a motor. The focal lengths of these lenses were such as to give images of the sun which, in our judgment, would be suitable for exhibition, namely, with a diameter of from 4.5 mm. to 6.4 mm. Some difficulty was encountered in reducing sufficiently the brightness of the sun for the partial phase, as gelatin filters melted in the sun's heat. Of course, the lens had been stopped down to a very small aperture. In the future care should be taken that the leaves of the iris diaphragm are of material which will not curl in the heat. In the operation of this "battery," Captain Harris was to be assisted by Miss Mary R. Calvert, Miss Bertha Calvert, and a local photographer.

Captain Harris made short films of each of the pieces of apparatus in the camp in operation at rehearsals, and these were later combined into a reel of about seven hundred feet, which has been exhibited to their classes by a number of the members of our party.

It was a keen regret to all that the cloudy sky gave no return to Captain Harris for the hard work he had put into the preparation for the eclipse during his stay at Catalina and for some weeks previously.

10. Professor Elmer T. Merrill, of the Latin Department of the University of Chicago, has been interested in astronomical observations since his student days with Professor J. M. Van Vleck at Wesleyan, and has an excellent 4-inch Clark refractor on a portable equatorial mounting at his vacation home near Pasadena. He generously offered his instrument and services for the eclipse some months before the event. I recommended that he should use the instrument visually, and he accordingly went over the literature of visual observations of the

corona, and prepared himself for careful sketches of it. His instrument was set up in a quiet corner of the camp, and if the sky had permitted, we should confidently have expected interesting drawings of the corona by an observer considerably experienced in visual work.

Father Luis Rodés, director of the Observatorio del Ebro at Tortosa, Spain, gave us a pleasant surprise by arriving at Avalon a few days before the eclipse. He decided to make visual observations of the corona as well as of the shadow bands, and stationed himself near Professor Merrill.

11. The shadow bands have been observed at eclipses for many years, but little advance has been made in our knowledge of them because such conflicting and even contradictory statements have been made by observers of them at the same eclipse. The phenomenon is partly meteorological, and may not be regarded as of special astronomical interest. However, as little increase in our knowledge is likely to come from merely visual observations, I decided that we ought to make an attempt to secure photographs of these fugitive alternations of light and shade. Serious attempts to photograph them with adequate apparatus does not appear to have been undertaken until the Australian eclipse of 1922, when Professor Chant made exposures for the purpose which were unsuccessful. Inasmuch as the highest degree of technical skill in photography with special equipment would be necessary, I tried to interest some of the officials of the research laboratory of the Eastman Kodak Company to undertake these observations themselves. It was too late for this to be arranged, however, and we proceeded with our own plans with the benefit of very helpful advice from Dr. Frank E. Ross and others of that Company.

Some experiments by Dr. Lewis E. Jewell of that Company had shown that an exceedingly fast combination could be secured by using in succession some "gun-sight" achromatic lenses. A set of three such lenses, loaned to us by the Company, mounted in a tube, reached our camp about three days before the eclipse. The aperture of these lenses is 36 mm., focal length 100 mm., and the equivalent focal length of the combination of the three 52 mm. This brought the focal plane within eight millimeters of the back surface of the rear lens. The speed of the combination was of course very high, with a focal ratio of about 1.4—which could be made even less. It was not possible at the camp to adapt this combination of lenses to a movie camera, as the very short distance between the surface of the rear lens and the film would require alterations in its mechanism. I had, however, taken to the camp several small brass plate-holders from a spectrograph, and it was not difficult for our efficient instrument maker, Mr. Ridell, to construct the wooden attachment for fastening the plate-holder to the tube, as well as to make an exposing shutter with a narrow slit operated by rubber bands, giving an exposure of about one hundredth of a second on the Paget "Hurricane" plate.

PLATE VII

VIEW FROM CAMP WRIGLEY TOWARD AVALON.
Camp in early stage of construction.

VIEW OF CAMP WRIGLEY FROM THE SOUTHEAST.
Much of the apparatus in position.

Dr. J. S. Plaskett, director of the Dominion Astrophysical Observatory at Victoria, who was to observe the eclipse at our camp, kindly agreed to make the exposures with this instrument. A screen of white cloth, about 8 x 8 feet, was stretched on a frame and set up perpendicular to the direction of the sun at the time of totality. A meter stick and other wooden strips of different width were placed on the screen to give the scale. Mr. Plaskett focused the instrument for a distance about six feet from the screen.

Professor William D. MacMillan, of the University of Chicago, was to operate a Universal movie camera having a Tessar lens of ratio 3.6. The film for use with this instrument was of superspeed, made by the Eastman Kodak Company. The machine was to be turned twice per second for the half minute preceding totality and once per second during the corresponding time after totality.

Professor N. B. MacLean, of the University of Manitoba, also participated in these observations, being prepared to operate a hand camera in the chance of catching the bands. Miss Elizabeth W. Laird, of Mt. Holyoke College, was to record the visual observations or remarks made by these observers. Although the clouds did not give us the slightest chance of observation of the shadow bands, we hope that our preparations may be of some value for future observations.

Miss Annie J. Cannon, of the Harvard Observatory, arrived at camp on September 7, bringing her photometric box for recording the intensity of the coronal radiation through different filters. A wooden post was set up for her near the optical pyrometer, and Mrs. Kingston was her recorder.

The visual observations made under the auspices of the Northwestern University by Messrs. Wylie and Curtis, under the direction of Mr. Fox, were intended to record with chronographs the times of appearance and disappearance of the different lines in selected regions of the flash spectrum.

Mr. Henry G. Peabody, well-known as a photographer of natural scenery, turned up at the camp having in his equipment a "Protar" of about 20 inches focus for the photography of the corona, and was invited to come within the lines of the camp. Professor Wm. P. Boynton, of the Department of Physics at the University of Oregon, was to act as recorder for Mr. Peabody. These gentlemen are graduates of Dartmouth in the classes of 1876 and 1890 respectively.

W. R. Jewell, Esq., of Danville, Illinois, having completed his labors in the preparations for the party from the University of Wisconsin under Professor Stebbins, set up his portable telescope near our flag pole for visual observations of the corona.

The party from Carleton College, consisting of Professors H. C. Wilson and E. A. Fath, erected their instruments at a point about forty meters north of our shop and office. At about the same distance slightly to the west was the hut built by the party from the University of

Wisconsin for photo-electric observations, described by Mr. Stebbins in this magazine for January. President D. W. Morehouse, of Drake University, set up his photographic equatorial about twenty meters from us. The other members of his party were Messrs. Wifvat, Daniels and Charles Morehouse.

Accurate time was provided for the camp and all parties through the coöperation of the Elgin National Watch Company who sent out their astronomer, Dr. F. D. Urie, provided with a first class radio receiving set and several ship watches. Mr. Urie was able to get the signals from Annapolis, and the accuracy of the time was assured. At all rehearsals and at the calculated time of the eclipse, seconds were counted out by Professor H. R. Kingston, of the University of Western Ontario at London, who performed a similar service for us at the eclipse of 1918. He found it convenient to use a stop watch for the sake of avoiding errors in the whole number of seconds. The count was to be maintained for a half minute after the one hundred and sixty-nine seconds of calculated totality at our station, so that the observers of the shadow bands could hear him. Inasmuch as none of those operating the spectroscopes had ever observed the oncoming flash, the responsibility of announcing this was taken by Professor H. C. Wilson, veteran of four eclipses, who was to have watched the narrow crescent in the finder of his telescope, and expected to call out the word "flash" about two seconds before the estimated entire disappearance of the crescent. The count was to be taken up by Dr. Kingston at the word "go" from Dr. Wilson.

A small model of the proposed installation of Camp Wrigley had been set up at the Yerkes Observatory early in the summer, and was quite closely followed except for some changes necessitated by the lay of the land. From the topographic map of the United States Coast and Geodetic Survey, we chose a location for our station not far from the "Summit." I am greatly indebted to Dr. A. van Maanen, of the Mount Wilson Observatory, who looked over the possible sites along the mountain road from Avalon to the Isthmus during a visit to the Island some months previous to the eclipse, and took snapshots of some positions which seemed to him suitable. Professor Frank P. Brackett, of Pomona College, who has long been familiar with the Island, also very kindly gave us the benefit of his experience and advice which concurred with that of Dr. van Maanen with respect to a site near a spring and not far from the Summit. Mr. Brackett established the Pomona College station on the Island at the "Isthmus" which was some twenty miles along the mountain road from Camp Wrigley.

The advance guard of our party were Mr. Lee and Mr. Foote, the latter accompanied by his wife and his son, Harold. They reached the Island on August 1, and, with every assistance from the officers of the Catalina Island Company, decided on the actual location of the camp, which Mr. Lee later found to be about one hundred and fifty feet below

the Summit, or thirteen hundred feet above the sea—in latitude 33° 20′ north, and longitude 118° 20′ west on the map. They attended to all the many preliminaries necessary to get the buildings erected. The Company very generously offered every facility at their mills and shop without profit, and gave us the privilege of using the Mountain Road which is not opened to the public. Mr. Lee purchased at Los Angeles the second-hand Dodge truck which was necessary for the daily transport of our materials and light instruments and of our observers up the steep climb of three miles from our headquarters at the Island Villa, a spacious and comfortable tent colony operated by the Company in Avalon. The coöperation of the citizens of Avalon was most cordial in every way, and we were able to borrow and purchase many utensils which were indispensable to us. Mr. Lee also acted as disbursing agent for the party, and cheerfully and helpfully attended to a great many details for the benefit of the camp and of the many individuals directly and indirectly connected with it. He was the last of our party to leave the Island on September 15. The Catalina Island Company greatly relieved our fear of overdrawing our funds by taking off our hands at a fair price the automobile and material left behind at our camp.

Weather Conditions: During the forty days prior to the eclipse, the sky was clear and generally very fine at eclipse time, 12:54, on thirty-five days. On August 17, the sun was covered at eclipse time with passing clouds, which would have permitted some observation; on August 24, it was cloudy throughout the day, and observations of the eclipse would have been impossible; the condition was similar on the following day. We found that a heavy fog over the station in the morning up to about nine o'clock gave good promise of a clear day; but if there were no fog in the early morning, then clouds might develop by noon. On September 2, there were some haze and cirrus clouds at the time of eclipse which would have interfered with spectroscopic and photometric observations, but would have permitted photographs of the corona. On September 3, conditions were hopeless; there was no fog in the morning and the whole day was cloudy. This record thus shows that the chance of a clear sky on September 10 was around eighty-seven per cent. Generally speaking, the conditions throughout our stay at the camp were ideal with respect to weather. The situation a few hundred feet below and east of the high ridge protected us from any southwest winds from over the sea. On some days the transparency was sufficient for us to see the structure of the tower telescopes at Mount Wilson about sixty-five miles away. Thus we had every scientific reason to be satisfied with the location of our camp.

Conditions at night were less favorable than by day, as a fog might come in at any time in the evening or night; when clear at night, it was very fine. Under all the circumstances, and in comparison with the reports of conditions by day and night at other eclipse camps along

the track in California, I cannot see how we could have made any better choice of location.

Readings of the temperature were made at 7 a. m., 1 p. m., and 7 p. m., by Mr. Foote. During the period from August 10 to 20, the highest temperature at one o'clock was 85° on August 12; the lowest at morning or evening was 62° on the evening of the same day. During the next ten days, these extremes were 87° on August 25, and 58° on the morning of the 30th. During the ten days ending September 9, the extreme shade readings were 98° on September 8, and 63° on the morning of August 31. In the week beginning September 2, the weather became very hot during the day, with the temperature reaching well above 90° during six of those days. The result was that the dark room, which was a part of the same structure as the large plate-holder, was intolerably hot during the daytime (117° F. was noted), rendering the development of the test plates difficult and requiring the use of ice. Practice in operating the large plate-holder at such temperature was thus quite a physical ordeal, and would have been so for Mr. Lee during the half hour or more in which he would have been incarcerated at the time of the eclipse. We ought to have planned much better ventilation for our dark room and plate-holder, and we offer this suggestion to future observers of eclipses in warm climates.

The camp was undisturbed by winds during the daytime, and on the finest days there was usually a very gentle draught up the slope from the east; but on two nights a rather heavy west wind blew for some time, on one occasion bringing down our flag pole.

On the morning of September 10, there was no fog at the camp and very little at Avalon, which was unpromising. "Native sons" called it a high fog, but we visitors were ready to designate it as a thoroughly cloudy sky, and newspaper reports of the flights of naval aeroplanes at San Diego stated that the cloudiness extended up for at least three miles.

This disappointing condition of the weather along the whole track south of us (even extending into Mexico) was a matter of very sincere regret to the citizens of California who take a certain pride in their climate. The conditions were surely exceptional according to all weather observations. September 11 was even a worse day, wholly cloudy and with some rain at our station.

Readings of the temperature were systematically made during the progress of the partial eclipse by Mrs. Foote, and they showed some changes, but under such cloudy conditions they cannot be regarded as measuring the fall in temperature due to the eclipse, and therefore are not given here. The degree of darkness at totality was considerable, but it was always possible to read a watch, and the actual time of beginning and end of totality could not have been estimated within several seconds.

During totality, it was arranged to have three "trouble doctors,"

Mr. Ridell for the coelostat, Mr. Foote for the camp in general, and Harold Foote for the large plate-holder from the outside. It was our policy, as it doubtless has been that of those more experienced in observing eclipses, that in case of failure of any piece of apparatus during totality, the responsible observer must correct it himself, or have it corrected by his trouble man, but no observer should allow his own program to be interrupted by the possible difficulties of any other.

A pleasant feature of one evening of the week prior to the eclipse was a meeting at the school house in which representatives of all the parties explained their plans to their colleagues. This brought out an interesting discussion on a number of points, and became in effect a symposium on eclipse observations. A resolution of sympathy was there adopted for the sufferers from the terrible destruction which had just occurred in Japan, particularly having reference to the astronomers at the Tokyo Observatory.

The principal hazard, aside from that of automobiling on the Mountain Road, was that of fire, which was really serious, but with the aid of a group of men furnished at the start by the Company, the area to be occupied was carefully burned over. Another was that from numerous bands of wild goats on the Island (from stock left by the Spaniards some seventy-five years ago), which might get into our camp and browse upon or otherwise injure our equipment, but only on one occasion were there tracks found within the borders of the camp. A single rattlesnake was observed within the camp early one morning by Mr. Foote, but he made his departure so quickly that he could not be killed.

Although the expedition was a failure from the scientific point of view, we nevertheless have the satisfaction of knowing that our preparations were quite well carried out, and there was a spirit of cooperation and good will amongst the large number who were associated with the various parties at the camp. Among the different institutions unofficiallly represented at the camp, besides those mentioned above, are the following: Dudley Observatory, University of Illinois, Lake Erie College, Princeton University, Washington University of St. Louis, and Wellesley College.

I have very inadequately expressed our obligation to many who assisted to make the occupation of Camp Wrigley both possible and pleasant. I should like to name in particular, aside from the donor of the fund, Captain D. M. Renton and Mr. Charles Hammond. Mr. Ernest Windle, editor of *The Catalina Islander*, and municipal judge, was also helpful to us in many ways. I must not fail also to express thanks to those who kept the home fires burning at the Yerkes Observatory during the absence of most of the rest of the staff: Messrs. Barrett, Van Biesbroeck and Struve.

THIRTY-FIRST MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

(Continued from page 169.)

ABSTRACTS OF PAPERS

AN INTERESTING STAR NEAR 61 VIRGINIS.

By Harold L. Alden.

The star H.D. 115559 (R.A. $13^h\ 12.8^m$, Decl. $-17°\ 47'$, 1900) has a proper-motion of 0″.182 per year in the direction 222°.9. The motion of 61 Virginis is 1″.525 in the direction 224°.8. The directions are so nearly equal that it seems quite probable that the two stars have a common motion in space. From the proper-motions the fainter star is found to be eight and one-half times as far away as the brighter star.

The apparent magnitude of the fainter star, 9.2, combined with an assumed absolute magnitude for the spectral type G0, which is the spectral class in the Draper Catalog, indicates a parallax of 0″.12. This is one-tenth of the parallax of 61 Virginis and lends added weight to the belief that the stars are moving toward a common vertex.

The fainter star is nearly three hundred light-years from 61 Virginis and it will be interesting to establish the common motion of the two stars by a determination of the radial velocity, if possible.

RADIAL VELOCITIES OF S SAGITTAE.

By J. A. Aldrich.

One hundred and twenty-four spectrograms of S Sagittae, made at the Detroit Observatory over a period extending from 1913 to 1923, have made possible an analysis of the complex velocity variations of this Cepheid variable. Three periodic curves, when combined, represent the velocity observations of S Sagittae satisfactorily. The elements of these three curves follow:

	Long Period	Light Period	Secondary
P	682 days	8.381589 days	4.191 days
T	1914ª May 26	1913 May 7.01 G.M.T.	1913 May 3.14 G.M.T.
e	0.16	0.34	0.09
ω	195°	52°.8	145°.7
K	15 km	15.1 km	3.5 km
$a \sin i$	136×10^6 km	1.635×10^6 km	.....

The first curve is most certainly orbital and discloses a distant companion. The second and third curves are almost certainly due to the vertical atmospheric motions. Elliptical elements are used here merely to express the form of the last two curves. The velocity-curve of the same period as the light-curve, is an irregular one, represented well by the last two sets of elements combined. A comparison of this irregular

curve with a recent light-curve by R. H. Curtiss reveals a striking resemblance between them.

A most significant result which developed in this study followed from the determination of velocity-curves of the 8.4 days period, based on three groups of lines chosen with a view to sorting out absorbing layers on a basis of levels in the atmosphere of S Sagittae. The three available hydrogen lines were placed in a group presumably of highest level. Six chromospheric lines of intermediate levels, as determined by Professor S. A. Mitchell for the sun, were selected for the second group, and the remaining lines were taken to represent on the average low level or reversing layer conditions. The velocity-curves for each of these three groups of lines when compared show clearly that the motion of the upper layers follows in time that of the layer or layers below; that there is a lag of phase of the velocity-curves as we proceed upward in the star's atmosphere. Also there is strong evidence that the radial velocity range is greater for the higher atmospheric levels in S Sagittae. Finally the different vertical motions in different layers of this star's atmosphere are found in each light cycle to lead to a period of atmospheric compression, reaching maximum at near the time of light maximum, and to a stage of atmospheric expansion culminating at or near light minimum. These relative atmospheric motions, which most certainly affect the photospheric region, are probably competent to account for the light variations by the effects which they produce both on radiation and absorption at the star's surface.

RESONANCE IN ASTEROID MOTIONS AND ITS TREATMENT.

By Ernest W. Brown.

Cases where the periods of two bodies are in an exact integral ratio exist in several parts of the solar system, notably in the periods of rotation and revolution of the moon and in the periods of revolution of the Trojan group of asteroids and of Jupiter. Other cases should exist, for example asteroids of period half that of Jupiter, but none are known to fulfill this condition with certainty. The chief features of a resonance case were pointed out by analogy with the motion of a pendulum. Since the period of a libration depends to some extent on the amplitude, it was pointed out that in certain cases this was sufficient to prevent the libration turning into a complete revolution. In other cases it is not sufficient, so that the resonance could not persist. It was pointed out that a certain close relation between the periods of Jupiter, of the librations of the Trojan group and of their perihelia might ultimately have the effect of making the eccentricities so large as to destroy the configuration. It is conjectured that a similar cause may account for the gaps in the distribution of the main body of those asteroids which lie between the orbits of Jupiter and Mars.

PLANETARY OCCULTATIONS.

By L. J. Comrie.

These may be defined as occultations of stars by planets and their satellites. From their observation we may hope to gain information concerning the positions, diameters and atmospheres of the occulting planets, also concerning the deflection of light in a gravitational field. Already a number of valuable results have been obtained. Struve, from a widely observed occultation of a 7th magnitude star in 1903, found a correction to the tabular diameter of Jupiter that was confirmed later by Sampson's study of the eclipses of the satellites. Ristenpart in 1911 found that the third satellite of Jupiter was larger than had previously been supposed. Observers of the occultation by Venus of η Geminorum in 1910 and 7 Aquarii in 1918 found the diameter to be less than that adopted in the ephemerides. The transparency of both rings of Saturn was well established by occultations of 7th magnitude stars observed in 1917 and 1920. The existence of an atmosphere on Venus is inferred from the two observations cited above. Regarding the atmosphere of Jupiter the observations lead to somewhat contradictory results, but on the whole favour the theory that the transparent atmosphere is very small.

If a series of plates could be exposed on a star near which Jupiter passed, it might be possible, by measuring the series in the way in which parallax plates are measured, to determine the Einstein deflection. This deflection amounts to 0″.017 at the limb, a small quantity certainly, but comparable with many parallaxes that have been measured.

Predictions relating to planetary occultations appear regularly in the *Journal of the British Astronomical Association*. However, none of these phenomena may be observed in the United States in 1924.

CHANGES IN THE MAGNITUDE AND SPECTRUM OF R SCUTI.

By Ralph H. Curtiss.

Twenty-two single prism spectrograms of R Scuti were secured by the writer at Lick Observatory in 1903. Observations were resumed at Ann Arbor in 1911, since which time more than 200 spectrograms of this star have been secured. In 1905, ten of the 1903 plates were measured and all were studied qualitatively. The radial velocities were subject to a variation with a range of a little more than 10 km/sec. and a period of about 70 days. The mean velocity was about + 40 km/sec.

Twenty-five spectrograms of 1911 and twenty-two of 1912 have been measured and studied in a preliminary way. The radial velocity

was found to be variable with a range of 10 or 11 km/sec. The period proved to be variable but between 65 and 75 days. The velocity-curves obtained were not interpreted as orbital but, described in the usual way by elliptical elements, the eccentricity would be 0.23 and the longitude of periastron 300°. The center-of-mass velocity referred to the sun was + 42.5 km/sec., and referred to the stars, + 58 km/sec.

Emission line velocities of Hβ, Hγ, and Hδ, all determined just after principal minimum when these features were sharp, were about 10 km/sec. less than absorption line results and fell more below the latter as the light maximum was approached.

Changes in the intensity of the Hγ absorption correspond closely to the light variations but with a tendency to precede in their phases the corresponding features of the latter curve. With increasing light the hydrogen absorption became weaker and vice-versa, in general. A cycle of change affecting the hydrogen lines in 1911 and having the same period as the velocity variation was described.

Attention was called to a period of nearly constant light at about 5.6 magnitude from April 15 to July 20, 1912. During this period of reduced light change in 1912 there was corresponding inactivity in the hydrogen lines.

A curve showing the relations between period and velocity range in Cepheid variables was thrown on the screen; and also a curve bringing out a possible relation between period and longitude of periastron in these variables. In each case the extension of the curve to include R Scuti was suggested as a possibility.

PARALLAX NOTES FROM THE ALLEGHENY OBSERVATORY.

By Zaccheus Daniel.

The parallax of Nova Cygni 1920 derived from 28 plates with three exposures each, covering the interval from September 1920 to October 1923, is +0″.018 ±0″.006 relative to four comparison stars of about 12.5 photographic magnitude. The annual proper motion in right ascension is + 0″.009 ±0″.004. The probable error for one good plate is ±0″.019. The usual exposure was four minutes, increased to eight in 1923. The mean parallax of the comparison stars is probably not far from +0″.002, which makes the absolute parallax+0″.020. At maximum light the visual magnitude of the Nova was about 1.9. The corresponding absolute magnitude is —1.6 which is more than 400 times the luminosity of the sun.

The parallax of Vega derived from 27 plates, desensitized by Dr. Burns using a one per cent solution of copper sulphate on a small area at the center of the plate, combined with 8 plates taken with an absorbing screen, is +0″.117 ±0″.005 and the annual proper motion

in right ascension is $+0''.212 \pm 0''.003$ relative to four comparison stars of about the tenth magnitude. The probable error for one good plate with three exposures is $\pm 0''.022$ which compares favorably with the results for plates not desensitized. This parallax compares well with Yerkes $+0''.114 \pm 0''.010$ from 17 plates with a double sector and McCormick $+0''.131 \pm 0''.006$ with an absorbing screen. Boss furnishes $+0''.209$ for the absolute proper-motion in right ascension.

PHOTOMETRIC STUDY OF THE ECLIPSING VARIABLE R CANIS MAJORIS.

By Raymond Smith Dugan.

The normal minima, which Hellerich (*Astronomische Nachrichten*, No. 5167) has formed with his new elements, J.D. $2410357.6379 + 1^d.13594989\,E$, taken by themselves, do not indicate, consistently, any change in the period for the thirty years from 1887 to 1917. The Princeton observations from 1917 to 1923, taken by themselves, are consistently represented by the elements J.D. $2422030.6375 + 1^d.135939\,E$. There may have been an abrupt change in the period about 1913-14.

Circular orbital elements have been determined from the mean curve. The darker star is slightly the smaller and radiates about one-sixteenth of the combined light. The anomalous hump in the curve at the end of primary minimum observed by Pickering and Wendell, either has disappeared or moved along the curve several hours. Wendell's primary minimum is wider and deeper, the secondary also deeper, than mine. Wendell's curve yields the same value for the ratio of the radii of the two stars and an inclination to the line of sight one degree greater. The greatest disagreement is in the light of the fainter star. The value from Wendell's curve is between one-sixth and one-seventh of the combined light.

A NEW CELESTIAL GLOBE FOR THE USE OF STUDENTS.

By John C. Duncan and Leah B. Allen.

For the teaching of elementary astronomy by laboratory methods a good celestial globe is exceedingly useful, not only because it is the only representation of the sky that is free from distortion, but more especially for solving elementary problems in spherical astronomy. No globe well adapted to this purpose has been on the market for many years. The new globe discussed in this paper was designed for use in classes at Wellesley College after many unsuccessful attempts

to obtain a suitable globe ready made. The design combines the desirable features of a number of older globes, and includes some others that, so far as the authors are aware, are new. The following points are mentioned:

1. The diameter is eight inches. This is large enough to show all necessary stars and circles, and yet not too large to be used by the individual student when seated at a table, or to be stored conveniently in considerable numbers.

2. The stars positions are referred to the equator and equinox of 1950.0, a century later than the epoch of most existing globes.

3. In order to simplify the map, the mythical constellation figures are omitted and only about 400 stars shown—those that are essential for recognizing well-known groups. Names are given for the principal stars and constellations, and Greek letters for the stars.

4. The star symbols are arranged on a logarithmic scale, the area of the symbol being proportional to the light received from the star. Magnitudes are further distinguished by characteristic patterns.

5. The equator is divided to ten minutes of time instead of degrees, and the hour-circles are numbered plainly with Arabic instead of the customary Roman numerals.

6. For reading celestial longitude, the ecliptic is graduated to degrees, which are numbered (on the north side) from 0 to 360 instead of from 0 to 30 within each "sign" as on older globes. The position of the sun for every tenth day is indicated on the south side of the ecliptic by printed dates.

7. The galactic circle is shown, and is divided to 10° for reading galactic longitude.

8. All reference circles, star symbols, and names are printed in black; the background is blue with the Milky Way stippled in white.

9. The globe is "full-mounted" on a hardwood stand with metal meridian and horizon rings, which are graduated to degrees.

10. The degrees of the horizon are numbered from 0 at the south point through 90 at the west to 360. The usual diagram of the signs of the zodiac is omitted.

11. One half of the meridian ring is graduated on its inner circumference and numbered from 0 at the equator to 90 at each pole for reading declination. The other half is graduated along its outer circumference from 0 at each pole to 90 at the equator, for adjusting to the observer's latitude by reading the altitude of the pole.

At the presentation of the paper there were shown a preliminary sample globe made by Rand McNally & Co. of Chicago and printed from the black plate only, a preliminary proof of the blue plate of half the globe showing the Milky Way, and a sample hardwood stand made by the Eastern Science Supply Company of Boston.

THE ALGOL VARIABLE X TRIANGULI.

By Frank C. Jordan.

This variable has a magnitude range from 8.88 to 12.00. Two others have a greater range: SX Hydrae, 8.6 to 12.6, and RW Tauri, 7.14 to 11.0. The rate of change of light of this star near the bottom of the curve is one magnitude in 14 minutes, probably the most rapid change of any known variable. It is not as yet sufficiently observed for the computation of definitive orbital elements.

REMARKS ON THE LUMINOSITY CURVE.

By W. J. Luyten.

1. From the published trigonometric parallaxes, supplemented by spectroscopic, dynamical, and, in the southern hemisphere, very largely by spectral proper-motion parallaxes, a list of 803 stars has been compiled, for which the parallaxes exceed 0".0395.

2. According to Kapteyn's density law there should be 3,060 stars closer than the limit indicated by this parallax. It is obvious that the present list is very incomplete as regards the absolutely faint stars, but it may be complete for the absolutely bright stars.

3. A comparison with Kapteyn's luminosity curve shows that the present list contains *more* absolutely bright stars. The numbers obtained from a combination of the density and luminosity laws only agree with these observed for stars as faint as absolute magnitude + 4 for which stars our list cannot be hoped to be complete.

4. We conclude that the local density of giants is large, but that probably the giants are more numerous in space than Kapteyn's data indicate, and also that the general star-density may be a little higher than Kapteyn's value.

5. From Kapteyn's density and luminosity laws we find that of the stars brighter than apparent magnitude 8.25 there should be 34,000 whose absolute magnitudes lie between —1 and +2, and about 8800 between —4 and —1. From the data given in *Harvard Circular* 226 and from our present conceptions of the mean absolute magnitudes and their dispersion for giants, we find that these numbers are probably 41,000 and 2,200. In both cases the total number of giant stars is 43,000, but Kapteyn's curve gives about four times too many "supergiants," and not enough ordinary giants.

6. When plotting the absolute magnitudes of our eight hundred stars against their spectral classes, we find the dwarf-branch very prominent. The dispersion in absolute magnitude is probably too small, owing to the inclusion of so many stars on the strength of

spectral proper-motion parallaxes alone. In addition to the three well-known white dwarfs there are shown: o Ceti B, 72 Columbae, and Cordoba 32,416. There is only one giant between A3 and K0, viz. Capella. One variable star is shown, o Ceti, which, however, may be farther distant than the adopted parallax indicates. The most remarkable feature of the diagram is the absence of a clear separation between giants and dwarfs for class K. In fact the change is so continuous that the diagram looks more like an inverted y than like an inverted 7.

ON THE LONG-PERIOD VELOCITY-VARIATION AND THE ABSOLUTE SCALE OF THE SYSTEM OF ALGOL.

By Dean B. McLaughlin.
(Introduced by R. H. Curtiss.)

One hundred and fifty-six spectrograms taken at Ann Arbor have served to verify further the long-period variation of the center-of-mass velocity of the eclipsing pair, found by R. H. Curtiss and Belopolsky. A velocity range of 20 km in a period of 1.885 years is found, in substantial agreement with R. H. Curtiss' determination of 1.899 years. The period of 1.624 years is completely disproven.

The limb velocity effect discovered by Rossiter in β Lyrae is found to have a range of 35 km in Algol. Assuming equality of revolution and rotation periods, the limb velocity effect is applied to a determination of the absolute dimensions of the system. This is the only method at present available for the determination of dimensions in systems having only one measurable spectrum.

The dimensions of the system are as follows: (Sun = 1)

Radius of bright star	3.12
Radius of faint star	3.68
Mass of bright star	4.72
Mass of faint star	0.95
Density of bright star	0.16
Density of faint star	0.02
Radius of relative orbit	15.1 = 10,522,000 km
Mass ratio	$m_b = 5.0\, m_f$

It is the intention of the writer to apply the same method to the determination of the dimensions of other bright eclipsing binaries.

THE ATMOSPHERES OF THE OUTER PLANETS.

By Donald H. Menzel.

The spectra of the four largest planets are crossed with heavy absorption bands, increasing in intensity with their distance from the sun, being strongest in Neptune. As distance alone seems to be the main

factor which determines the intensity of the bands and as neither mass, mean density, nor atmospheric density (surface gravity) put the spectra in the observed order, it is probable that the differences are due to lower temperatures arising from the increasing distance of the sun. This requires low planetary temperatures and a small ratio of intrinsic to solar heat. It seems likely, therefore, that some substance which dissociates at temperatures far below zero centigrade is present in the atmospheres of these planets, perhaps explaining why we have not previously matched the spectra in the laboratory.

A SPECTROSCOPIC NOTE.

By Donald H. Menzel.

In the G, K, and late F stars, the line 4375 $Y+$, when compared with 4351 Mg, shows a marked variation with absolute magnitude and very little with spectral class. This is a strong line, especially in the spark, goes high in the chromosphere, and has all the characteristics of an enhanced line. It is probably an ultimate line of $Y+$. This spectrum should be very like Sr and this line may be analogous to 4607 Sr. There is a line of $Sc+$ at 4247 which goes very high and is probably similar.

SOME OBSERVATIONS REGARDING THE CORONA OF 1923.

By John A. Miller and Ross W. Marriott.

The authors discussed the general aspects of the solar corona of 1923, the most unusual feature of which is a sheaf of streamers at each pole of the sun resembling not at all the polar rays. The measurement of the arches, found on the southwest limb of the sun on plates made by Dr. Douglass in western Sonora, and by the Sproul Observatory Expedition at Yerbanís, showed motion in the corona similar to that of the corona of 1918.

A COMPARISON OF THE AVERAGE VELOCITY OF BINARIES WITH THAT OF SINGLE STARS.

By J. H. Oort.

This paper is an attempt to throw more light on the correlation between the masses of the stars and their average velocities (recently suggested by several authors) by means of a comparison of the velocities of double stars with those of single ones. Evidence is given

that the brighter components of visual doubles are approximately equal in mass to single stars of the same absolute magnitude; in the material used here the mass ratio of the two components is estimated to be nearly 0.7, so that in comparing these doubles with single stars of the same absolute brightness as the brighter components we are comparing two groups of stars one of which is about 1.7 times as massive as the other. The ratios of the average radial velocity of the single stars to that of the doubles comes out as follows: 1.06 ± 0.07 for the A stars, 0.95 ± 0.09 for the F stars and 1.06 ± 0.12 for G and K stars having companions of late types. The average is 1.02 ± 0.05 whereas the factor expected for equipartition of energy would be 1.27 in this case. The double-star velocities do not seem to conform with a general equipartition but the material is too scant, especially for the later types, to permit any definite conclusion. Although we cannot prove that the masses of spectroscopic binaries are considerably larger than those of single stars it may be interesting to notice that in this case the mean ratio of the two velocities comes out 1.03 ± 0.05,

It was found that the average radial velocity of later-type stars with B or A companions is exceptionally small, and there are indications that these double stars should, according to their velocities as well as to their galactic condensation (which is nearly the same as that of the B stars and not comparable with that of ordinary K giants), be classified among the B and A types rather than among K and G, although for the brighter doubles the later-type components are on the average more than 2.5 magnitudes brighter than their B or A companions.

AN ASTRONOMICAL CEILING DESIGN.

By Edward C. Phillips.

A lantern slide was shown of the ceiling of the Library of Woodstock College, Woodstock, Maryland. On this ceiling, which is about 40 by 70 feet in size, there are depicted the solar system, a star atlas including stars down to the sixth magnitude, the orbits and appearance of a number of notable comets, a series of sun-spots, prominences and other phenomena. The design and the painting are both the work of Father Benedict Sestini, the first professor of astronomy at the College. The exact date of the painting is not recorded, but it was probably executed shortly after the erection of the building in 1869.

SOME PHOTOGRAPHIC MEASURES OF DOUBLE STARS.

By John H. Pitman.

Twenty-eight double stars were photographed with the Sproul refractor. Eighty measurable plates were secured. The magnitudes of

the pairs varied from $2^{M}.8$ to $9^{M}.7$ but the difference in magnitude between the components was on the average $0^{M}.3$. The exposure time varied from three seconds to nine minutes. The separation of the components varied from 1″.76 to 46″.3, the majority of the cases being under 4″.0. In no case did we measure overlapping images.

The plates were set up parallel to the equator by means of trails and the Δx and Δy measured. From these the position angle and distance were computed. All plates were measured by the writer and plates referring to ten doubles were measured by Professor R. W. Marriott.

Comparison with recent visual observations showed an average difference of 1°.5 in θ and 0″.14 in ρ. When corrections for orbital motion were made in those cases for which sufficient data was available, the differences reduced to 1°.0 and 0″.11 respectively. In the ten cases common to the two sets of photographic measures, the average difference in photographic results was 0°.5 and 0″.046 and the residuals, visual minus photographic, were of the same sign.

The measures will be published later.

THE FREQUENCY OF TOTAL ECLIPSES OF THE SUN AT A GIVEN PLACE.

By William F. Rigge.

No general rule can be formulated that will apply equally to every place on earth, but the facts for each must be examined individually. It was found that in Omaha no total solar eclipse will be visible during the next two centuries, nor has one occurred during the past four. Between the years 600 and 1800 A. D., Rome was privileged to see three such eclipses, and London two.

ATMOSPHERIC PULSATION OF η AQUILAE.

By W. Carl Rufus.

The Velocity-Curves. The mean velocity-curve using lines of all atmospheric levels shows a prominent "Stillstand" beginning at phase $2^{d}.5$ and lasting about one day. Velocity-curves for low, intermediate, and high levels, using selected lines originating at known heights in the atmosphere of the sun, and separate curves for hydrogen and strontium, have been determined. The "Stillstand" is more prominent for the high-level and the low-level curves; but is lacking for the intermediate level. The curves for the isolated elements emphasize the secondary maximum. The hydrogen curve shows a lag of phase, which increases to about one day at the time of maximum velocity.

The Curves of Velocity Differences. The curve, hydrogen minus intermediate, bears a striking resemblance to Wylie's photometric light curve of the star and to a spectral-variation curve prepared from Shapley's data. The "Stillstand" of the three curves occurs at the same time, which is one day earlier than the similar feature of the mean velocity-curve. The amplitude, which exceeds 20 km, is fully one half as great as that of the mean velocity-variation. The velocity-difference curve, intermediate minus low, in some respects resembles the reverse of the light-curve with synchronous "Stillstand."

ULTIMATE AND PENULTIMATE LINES IN SPECTRA.

By Henry Norris Russell.

An atom in its normal, or unexcited, state is capable of absorbing only certain spectral lines, corresponding to transitions from the state of lowest energy-content to others directly accessible from it. Lines of this class are characteristic of low-temperature sources, and the stronger ones appear when only traces of the element are present. In hotter sources, a sensible (though usually small) proportion of the atoms are in states of higher internal energy, and can absorb other lines, so that new groups come out as the temperature rises. Lines originating in the lowest level may be called *ultimate* lines (following de Gramont), those in the next level, *penultimate*, and those from higher levels *antepenultimate*.

Lists of these lines have been made for all elements for which spectroscopic data regarding the energy levels are accessible. The lowest term may belong to almost any type of series, and be single or multiple, and the ultimate lines appear singly or in complex groups; but in all cases they are characterized by easy reversal. The ultimate and penultimate lines of neutral atoms are prominent in sun-spots, and in the cooler stars (especially in dwarfs). Ultimate enhanced lines are strong in the arc, and even in the furnace, and in stars of solar type, while antepenultimate lines appear only in the spark and in hotter stars. Examples are the (H) and (K) lines of Ca+ contrasted with Mg+ λ 4481.

In the redder dwarfs (as Adams and Joy have found) the (H) and (K) lines are fainter than the pair of Al lines between them, (which are ultimate lines of the *neutral* atom) and the ultimate Ti lines near λ 5200 are stronger than the Mg triplet, (which is penultimate.)

Again, the iron lines that show bright in o Ceti at minimum are found to be the only ultimate lines in the part of the spectrum investigated.

Progress in the study of complex spectra is at present very rapid. With the work of a year or two more (especially on enhanced lines)

it should be possible to put the classification and interpretation of stellar spectrum on a really rational basis.

SERIES IN THE ARC AND SPARK SPECTRA OF TITANIUM.

By Henry Norris Russell.

Both the arc and spark spectra of titanium show conspicuous regularities of the type now familiar in many-lined spectra. Very numerous "multiplet" groups are present—the number so far recognized in the arc spectrum being 104, including 542 lines, and in the spark spectrum 48, including 175 lines.

Two systems of terms appear in the arc spectrum—triplets and quintets—the former accounting for 70 groups and 326 lines, the latter for 16 groups and 150 lines, and inter-combinations between the two for 18 groups and 66 lines. Ninety per cent of the lines of intensity 20 or more on King's scale are thus accounted for.

The Zeeman effect shows that a system of singlet terms also exists, but this has not been worked out.

In the spark spectrum, there is a system of doublet terms (accounting for 18 groups and 51 lines), and one of quartets, (9 groups and 65 lines) with inter-system combinations giving 21 groups and 59 lines. Many more lines remain to be identified. The arc spectrum of scandium is built on essentially the same plan.

Both arc and spark spectra exhibit in a very striking manner the regularities pointed out in other spectra by Sommerfeld and Landé. The alternation and displacement laws are exactly satisfied, as are also the inner-quantum rules—which make it possible to assign inner quantum numbers to all the terms, and tell to what series each belongs. The Zeeman patterns, whenever wide enough for resolution, are in excellent agreement with Landé's recent theory.

In the triplet system terms of series *s*, *p*, *d*, and *f* appear, and also those of the three following series, which may be called *g*, *h*, and *i*. In the quintets, *p*, *d*, *f* and *g* terms have been found. In the spark spectrum doublets of series *s*, *p*, *d*, and *f*, and quartets of types *p*, *d*, *f*, and *g* are recognizable.

The lowest energy-level in the neutral atom is a triplet *f*-term, and the next lowest a quintet *f*-term. Almost all the lines which are prominent at low temperatures in the furnace originate in the first of these levels—for example, the lines at λλ 5210, 5193, 5174, which are the principal resonance lines of the neutral atom. The correspondence between the temperature class of a line and the level in which it originates is very close, and has been of great aid in the analysis.

The isolated low-temperature line λ 4841 indicates that one singlet level is low—possibly, though not probably, lower than the lowest

triplet level. No series of terms, long enough to permit a reliable calculation of limits, has yet been found, but two or three short ones indicate that the ionization potential of the neutral atom is not far from 6 volts.

In the ionized atom the lowest level is a quartet *f*-term, and the next a doublet *f*-term. The former gives rise to lines at λλ 3384, 3373, 3361, and 3349, (and others of shorter wave length) which are strong in the arc, and even in the furnace, the latter to λλ 3761, 3759, and 3685, which are very prominent in the solar chromosphere.

NOTE ON SPECTROSCOPIC PARALLAXES OF DOUBLE STARS.

By Frank Schlesinger.

It has recently been shown by Pannekoek (*Bulletin of the Astronomical Institutes of the Netherlands*, No. 19) and others that the quantity called spectroscopic parallax is probably a function of the mass of the star concerned. An independent test of this question is afforded by those cases in which spectroscopic parallaxes have been determined for both components of a binary star. This note contains the results of the tabulation of the ratios of the spectroscopic parallax of the brighter component in each double star to that of the fainter component. The geometric mean of these ratios comes out $1.12 \pm .04$. On the average the bright star is 1.4 magnitudes brighter than the fainter; it is unquestionably likewise the more massive on the average and perhaps the more massive in each case. This ratio is in the direction and approximately of the right size to correspond with the findings of Pannekoek.

A GRAPHICAL METHOD FOR OBTAINING THE ELEMENTS OF ECLIPSING VARIABLES.

By Bancroft Walker Sitterly.

If the basic equation* in Russell's method for solving eclipsing variables,

$$\cos^2 i + \sin^2 i \sin^2 \theta = r_2^3, (\phi\, k, a)^2$$

be written in the form

$$\log S - \log r_2 = \log \phi\, k, a$$

where $S = (\cos^2 i + \sin^2 i \sin^2 \theta)^{1/3}$, this equation may be solved graphically with the help of certain auxiliary tables, in a manner which is very rapid in practice and indicates clearly the degree of uncertainty of the results.

Astrophysical Journal*, **35, 321, 1912, q. v. for the notation in these equations.

On the left side of the equation, log S is a function of i and θ, and we know from the light-curve of our star the value of θ for each value of n, where $\log n = \log a - \log a_0$. If i were known, we could plot log S against log n, obtaining a characteristic curve for the star (log r_1, though unknown, is a constant and will not affect the shape of the curve). On the right side of the equation, if k were known, we could plot log ϕ (which has been tabulated by Russell) against log a, and obtain another curve, independent of any observed quantities. If we now superpose these two curves, they should exactly fit; but the a-axis of the one curve and the n-axis of the other will not coincide, but be separated by the constant log r_1, while the ϕ-axis of the one curve and the S-axis of the other will be separated by the constant log a_0; so that the superposition determines the values of r_1 and a_0.

In fact, k and i are also unknown. But if, instead of one S-curve and one ϕ-curve, we superpose a set of S-curves, drawn for various values of i, upon a set of ϕ-curves, drawn for various values of k, and slide the curves over one another until an S-curve fits a ϕ-curve, we determine at once i, k, r_1, and a_0. And a little shifting about of the curves quickly shows how narrowly these quantities are determined by the observed curve (which is the basis of the S-curves).

Tables to facilitate the rapid plotting of the curves have been prepared, and details of procedure will shortly be published.

(Lantern slides illustrating the application of the method to the variable RZ Centauri were shown.)

THE GUIDING ERROR IN PARALLAX WORK.

By Frederick Slocum.

Most bad plates obtained in parallax work are bad because of faulty guiding. This may be due to the irregular running of the clock, to bad seeing, to an attempt to use too faint guiding stars, to want of experience or to lack of concentration on the part of the observer. The effect of bad guiding will vary with the difference between the magnitude of the parallax star and the weighted mean of the magnitudes of the comparison stars.

To obtain the quantitative determination of the effects of bad guiding, five plates of the Pleiades were taken with Alcyone at the center. On each plate there are four five-minute exposures. In the first exposure the guiding star was held on the cross thread for four minutes and then for one minute was swung slowly back and forth from the cross thread out toward the east over a distance about equal to the diameter of the star, estimated at about 2″. In the second and third exposures the guiding was as accurate as possible, and in the fourth the procedure was as the first, except that the start was swung to the west.

The effect of this bad guiding upon Alcyone and the three neighboring stars was studied. These four stars range in magnitude from 3.0 to 8.7. Six comparison stars with a mean magnitude of about 7.7 were selected and four sets of dependences were computed. Residuals were found for the four central stars as in parallax work. The mean of the residuals of the second and third exposures was adopted as a standard and the difference between this and the residuals for the first and fourth obtained.

The results are shown in the accompanying table. Star *d* is Alcyone, *a*, *b*, *c* the three stars forming a small triangle near Alcyone. The fourth column gives the mean diameter of the six comparison stars. The fifth and sixth columns give the residuals, m(west) for the exposure in which the guiding star was swung to the west, m(east) similarly to the east. A displacement of the central star to the east with respect to the comparison stars is marked plus, to the west minus. The scale of the plates is 1 mm = 25″.

Star	Magnitude	Diameter	Comparison Stars	m(west)	m(east)
a	8.7	.11mm	.16mm	+.0044mm	—.0044mm
b	8.1	.13	.16	+.0023	—.0018
c	7.0	.22	.16	—.0039	+.0062
d	3.0	.43	.16	—.0118	+.0081

The results are as expected, the brighter stars being displaced more and the fainter stars less than the comparison stars. Even in the case of the star *b*, where the difference in diameter is only .03 mm, the guiding error is conspicuous. This emphasizes the need of great care in reducing the size of an image of a parallax star to equal the mean weighted diameter of the comparison stars. Methods of accomplishing this were discussed. The Kapteyn method of photographing a star field through an extra-focal negative of the same region was tried. While the diameters of the star images were more nearly equal, the quality of the images was not good.

PHOTO-ELECTRIC PHOTOMETRY AT THE WASHBURN OBSERVATORY.

By Joel Stebbins.

A description was given of the new photo-electric photometer attached to the 15-inch refractor of the Washburn Observatory. The mounting of the telescope, although of old design, has been improved and adapted to photometric work which requires rapid changing from star to star. The principal innovation in the photometer is a universal joint, which allows the electrometer to hang vertically in all positions

of the telescope, even at great zenith distances. The instrument gives satisfactory measures of the light of stars, and two new variables were announced.

9 Andromedae, magnitude 5.90, single spectrum A0, period 3.21 days, has a light-range of about 0.15 magnitude. There are primary and secondary eclipses, with continuous variation between minima.

21 Cassiopeiae, magnitude 5.59, spectrum A2, was not known to be a spectroscopic binary, and was being used as a comparison star. Quite unexpectedly this object was found faint by 0.4 magnitude, and it turns out to be an eclipsing variable with about that amount of primary eclipse. There is a secondary minimum of something less than a tenth of a magnitude. The period as derived from the photometric observations is about 4.468 days. A determination of the spectroscopic orbit has been undertaken by Dr. J. S. Plaskett at the Dominion Astrophysical Observatory.

A NEW LENS WITH NON-SPHERICAL SURFACES.

By O. H. TRUMAN.

Lenses with non-spherical surfaces have of late years attracted an increasing amount of attention. The surfaces have in most cases, however, departed from spheres to only a small degree; the only exception known to the writer being the lenses with one parabolic surface, by Bausch and Lomb, which were the subject of a recent article in the *Journal of the Optical Society of America*. It is the purpose of this paper to describe a lens recently successfully tested, both of whose surfaces are non-spherical to a pronounced degree, and are believed to conform to no previously known curves.

As mentioned in a previous paper, great speed in an astronomical spectrograph for use on surfaces requires a high aperture ratio in the camera lens. Very good definition is also necessary, because of the fine detail it is desired to resolve. On the other hand, the angular field needs to be but a few degrees; achromatism is of no importance; and field curvature is easily compensated for by using film, held in a suitably curved holder, instead of a plate.

It was therefore believed that by discarding all useless requirements a lens could be produced with sharp definition over the necessary field, and of aperture fully equal to the focal length. After several months spent in a fruitless attempt to remove spherical aberration and satisfy the sine condition with a lens of three spherical-surfaced elements, a single element with non-spherical surfaces was resorted to. As one surface would remove the spherical aberration, two surfaces together should do this and satisfy the sine condition as well.

The corresponding problem with two reflecting surfaces was solved by Schwartzschild in 1905.* By proper choice of variables he succeeded in securing a differential equation which could be integrated. It is evident that the substitution of refraction for reflection would increase the difficulties enormously; the new differential equation would be so complicated that it is quite unbelievable that it could be integrated at all, save by a step-by-step process. It was therefore decided to resort to a step-by-step process directly, without a differential equation, and in this way the work was carried through.

Space does not permit a detailed description of the method of computation finally devised. In a general way, however, it may be said that the focal length and aperture, in this case 100 mm each, are decided upon, and the probable thickness it would be necessary for the lens to have. Then, taking a central radius of curvature for the front surface, the angle with the axis made by a normal to this surface at a point 2mm from the axis can be easily found. Given this angle, and the front and back focal lengths, the angle with the axis made by a normal to the back surface passing through the point of exit of the corresponding ray can be computed.

The departure from the sine condition is then found, and the original normal angle at the front surface, and that at the back surface, corrected by differential formulae so as to satisfy that condition. Thus one point off the axis is found for each surface.

Taking the two points now known on the front surface, the vertex and the one just computed, a third, 2 mm farther out and 4 mm from the axis, can be extrapolated, and it and the corresponding point on the back surface corrected as above, and so on.

Long before the edge of the lens is reached, a phenomenon will be found which at first, when it was not understood, gave a great deal of trouble. The lens will commence to curve rapidly either toward the front or the back, so that if the computation were carried on there would no doubt be formed a lip on the edge. This, if course is quite impermissible.

It was finally found that the difficulty lay in the fact that but one initial choice of the back focal distance for a given true focal length will give gradual curvatures clear to the edge, and the functions defining the front and back surfaces are so unstable with respect to the back focal length as a parameter, that this parameter must be chosen with great accuracy. The behavior is much like that of a billiard ball rolling down a cue—it is in unstable equilibrium; and the slightest departure from its proper place is rapidly increased.

Once the cause of the difficulty was found, the correct back focal length was arrived at by successive approximations.

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* "Astronomische Mitteilungen der Königlichen Sternwarte zu Göttingen. Zehnter theil." W. Fr. Kaestner, Göttingen, 1905.

The first lens of this type computed was of Para-Mantois 6567 glass, of 100 mm aperture and focus and 29 mm thickness, with front focal length for $\lambda = 4300$ of 13950 mm and back focal length 83.0 mm. The greatest departure from the nearest inclosing sphere amounted to 0.7 mm on the front surface, but only about a third as much on the back surface. It was computed that the accuracy of definition, even for the extreme rays in the spectrum range proposed, $\lambda = 3900$, would be within the limit of toleration.

The Lowell Observatory desiring such a lens, and thinking it better to attempt a half size one first, the writer computed another with Para-Mantois C 250 glass, of 50 mm aperture and focus and 16 mm thickness. The back focal length for $\lambda = 4400$ was here 40.6 mm and front focal length infinity. The greatest departure from a sphere was 0.37 mm.

This lens has recently been finished by Mr. John Mellish, and tests show it to perform in a most gratifying manner, and fully up to expectations. Figs. 1 and 2 show samples of spectra photographed with it, at 49 mm aperture, the spectra being a hydrogen tube with some impurities. The astigmatism is due to imperfect focusing of the collimator.

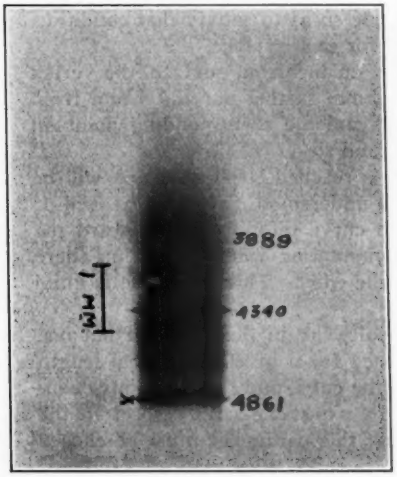


FIG. 1.

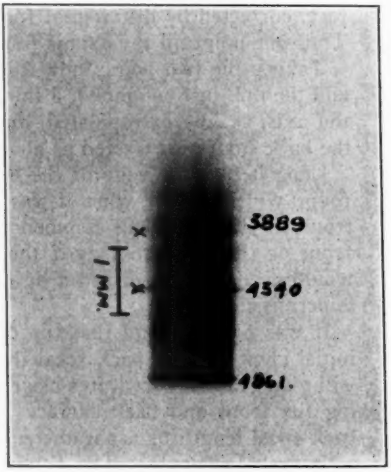


FIG. 2.

Each of the spectra, it must be borne in mind, can be expected to be sharply defined at only one region, as they were photographed on plates perpendicular to the axis of the lens, so that the full effect of chromatic aberration and field curvature makes itself felt. With the proposed curved film holder this will be done away with and the

PLATE IX

FIG. 1.
Hamilton 22°.4

FIG. 2.
Pickering 23°.7

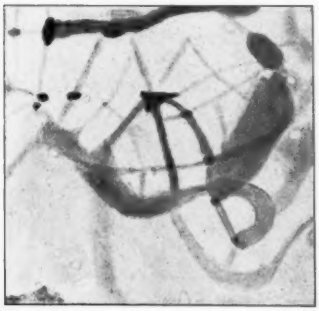


FIG. 3.
Hamilton 103°.4

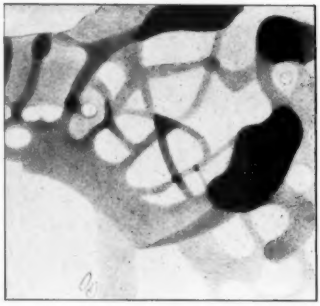


FIG. 4.
Pickering 100°.2

FIG. 5.
Hamilton 153°.9

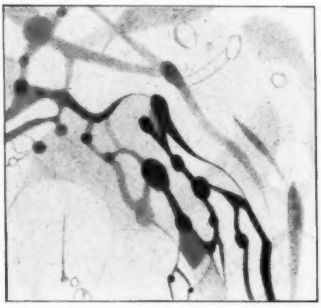


FIG. 6
Pickering 157°.7

CHANGES IN THE LUNAR CRATER ERATOSTHENES.

POPULAR ASTRONOMY, No. 314.

general appearance of the spectra much improved. The regions of good definition for which the spectra were selected are indicated by XX.

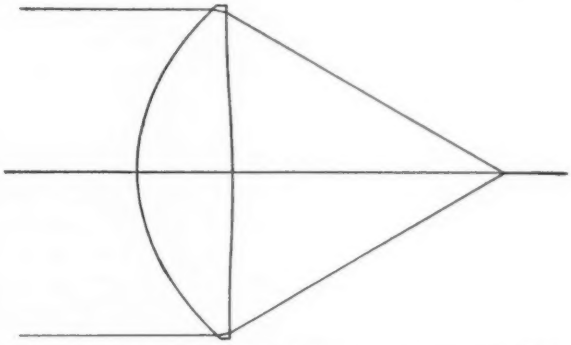


FIG. 3. A Non-Spherical Surfaced Lens of Aperture f/1.0.

The full-sized lens of 100 mm aperture and focus is shown in Fig. 3. Mr. Mellish is confident of being able to make larger lenses of this type even better than the small one, as the difficulty of detecting and removing zones decreases with increasing size. He is, in the opinion of the writer, deserving of the highest credit for the boldness, persistence, and originality with which he carried through this unprecedented piece of work.

4134 Fourth St., San Diego, Calif., June 26, 1923.

LUNAR CHANGES.
(Eratosthenes Region.)

By G. H. HAMILTON.

Are there physical changes now occurring upon the Moon? For many years the Moon has been regarded as a dead world—the writer himself often using this expression when referring to the Moon in contrast to the planet Mars.

It has been his good fortune to study this question at first hand by the side of its protagonist and he is fortunate in being able to secure three drawings by this authority to publish along with three of his own.

At first, when looking at a small portion of the lunar surface, one is apt to feel there is very little detail of interest to be seen. Detail is, however, very much worth observing for it can be seen to change from day to day. This change is generally—and with good reason—attributed to varying light and shade at different angular positions of

the Sun. It is only after careful and prolonged study that one is driven to conclude that there are *other* causes besides this necessary to produce the phenomena observed.

To illustrate, six drawings are reproduced—Figures 1, 3 and 5 by the writer, and Figures 2, 4 and 6 by Professor Pickering. These were made on the following dates: Fig. 1, Jan. 15, '24, Seeing 6-8; Fig. 2, Nov. 17, '23, Seeing 6-9; Fig. 3, Dec. 23, '23, Seeing 9-10; Fig. 4, Sept. 25, '23, Seeing 10-8; Fig. 5, Dec. 27, '23, Seeing 8-11; Fig. 6, Aug. 31, Seeing 11-10. In Figures 1 and 2 the Sun is rising over the western wall of the crater; the floor of the crater is free of shadow but there is a large and quite dark area east of the central peaks not attributable to shadow, but which gradually lessens in size and intensity as the lunation progresses. Upon the sun-lit wall at various levels dark markings can be seen, and these markings are of definite shape and contour.

Figures 3 and 4 show the crater as it appears with the Sun overhead; and as one would suppose, the crater itself is invisible, since there are no shadows due to a vertical Sun. But what a change in detail! Where one would expect no surface features at all, from lack of shadow on a dead and lifeless field and a uniform and unchanging brilliance lit by the noon-day Sun, one finds instead a *darkened* surface not only on the floor of the crater, but extending over and beyond its walls! It is said that this is shadow by those who do not believe in physical change. We are told that, however near the Sun may get to the vertical on the Moon, it never really does so—so that we may observe it—and therefore there can be deep clefts in the Moon's crust which would always show shadow. This is certainly true, if such clefts exist, but they must be either very deep or very narrow. To form a shadow at noon such as the dark marking which we will call for the sake of description the body of the crab, the cleft would surely nearly reach the center of the Moon, and at least would be visible as a cleft in the morning and evening drawings. It will be seen that this is not the case. Where one would expect to see this marking, under a slanting Sun in the first drawings, it is completely absent, and in the last drawing under an evening illumination it is only the ghost of its former self.

These comparatively large darkenings of the lunar surface certainly need explanation other than that of mere shadow formation. The crater walls, visible in the first and last drawings, show as terraces of step-like formation. Unfortunately for this explanation the shadows due presumedly to these steps or tiers of mountain ranges do not conform to optical laws, as can be seen by a comparison of the early and late drawings. A shadow, as will be noted, should move in an opposite direction to the motion of the Sun. Its Sun-ward bounding edge should remain *in situ,* while the shadow itself should gradually narrow until it vanishes altogether under a vertical Sun. This occurs in the

case of the central peaks as will be seen by a glance at the successive drawings.

For example, to the dark line or "run," Main, seen as a curved line near the center of the figure in the first drawings, with a triangular plat at its southwestern end, this law of shadows does not apply. Its concave edge is the Sun-ward edge and should remain stationary. By a glance at the later drawings it will be seen that it has straightened out, *both* its edges therefore having moved; and its southwestern end has shifted bodily *with* the Sun and has also intensified and changed its shape into a far more pronounced triangle. In the intermediate drawings there is a curved "run" ending in the triangular plat that could be mistaken easily for Main. This is not so, however. Main is the straight "run;" and it can be seen that the two runs have bent towards each other at one end until they coalesce. This movement, verified amply by micrometric measures, can be followed in its entirety; which precludes the possibility of this marking being really *two* shadows formed by the opposite sides of a cleft and switching over from the foot of one side to the foot of the other at the moment the Sun passed the meridian. This is obvious from another standpoint also—if it were such a cleft, at the moment of shift there would be no shadow—the marking would disappear. This is not the case. One could cite many more similar incongruities, which the reader will be able to note for himself by comparing the drawings.

That these changes occur, and occur regularly every lunation, cannot be doubted. The three drawings by the writer were done under unusual circumstances yet compare favorably with those of Professor Pickering. The latter has made many drawings of this region on the Moon, and corrected his drawings by micrometric triangulation of the whole region. He has been able to improve the position of the markings in each succeeding drawing by reference to his measures and previous drawings, so that the position of what he sees is very accurate. In the drawings made by the writer, he only used as a foundation three standard points taken from Professor Pickering's measures. These were: one of the central peaks (the southernmost), a small crater in the southeast corner of the drawing, and the large plat or dark marking seen in all the drawings nearly due south of the central peaks. It will be well also to say that these three drawings were the first that the writer has ever made of that region of the Moon, and for this reason the differences seen in the two sets of drawings are easily accounted for, but their similarity is such that either set can be taken as confirmatory of the other.

The real explanation of these lunar phenomena may still be hidden, but by amassing facts along these lines we are getting nearer to the truth. To further this study it might be well to make models of craters with jagged walls and floors of different substances and illuminate them with parallel beams of light at various angles; in this way

one could study the effect and perhaps come to some conclusion about these curious changes upon the Moon.

Mandeville, Jamaica, B. W. I.
January 19, 1924.

PROGRESS OF ZONE CATALOGS IN THE SOUTHERN SKY.

By J. HARTMANN.

In the December number of this Journal (p. 654) there is given a résumé of the Zone Catalog work being carried on at the two Argentine Observatories. While the outline of the undertaking as given by Professor Perrine is quite correct, the present condition of the work at La Plata is slightly different from that indicated, and at the suggestion of Professor Schlesinger I take this opportunity to give in detail the progress made in the La Plata zones.

Zone A. —52° to —57°, 7412 stars. Observed in 1913-1919 by Ing. P. T. Delavan. Published 1919 as Tomo V of the Publicaciones del Observatorio, La Plata.

Zone B. —57° to —62°, about 7800 stars. Observed in 1914-1920 by Ing. F. Aguilar. The manuscript is in process of preparation under the supervision of Prof. B. H. Dawson, and it is expected to begin printing before the end of 1924, as Tomo VII.

Zone C. —62° to —66°, 4412 stars. Observed in 1919-1922 by Agrimensor H. A. Martinez. In Press, as Tomo VIII.

Zone D. —66° to —72°, 4265 stars. Observed in 1919-1923 by Ing. V. Manganiello, and the reductions well along. Will form Tomo IX.

Zone E. —72° to —82°, about 3500 stars. Under observation by Ing. N. Tapia. Will form Tomo X.

Taking this in connection with the work at Córdoba, we obtain the following summary:

	Zone Limits		Area in Square Degrees	
Published	—22° to —32°		3203	
	—52	—57	1045	4248
In Press	—62	—66		631
Ready	—32	—37		1483
Nearly Ready	—57	—62	913	
	—66	—72	774	
	—82	—90	201	1888
Under Observation	—72	—82		808
Unattacked	—37	—52		3840

La Plata, February 1924.

PLANET NOTES FOR MAY.

The *Sun* will change its position in the sky from $2^h\ 31^m$ to $4^h\ 29^m$ and from $+14°\ 51'$ to $+21°\ 49'$ during the month. It will move from the constellation Aries into the constellation Taurus. It will pass between the Pleiades and the Hyades, and at the end of the month will be a short distance north of the bright star Aldebaran.

THE CONSTELLATIONS AT 9:00 P. M. MAY 1.

The phases of the *Moon* will occur as follows:

New Moon	May 3 at	5 P. M.	C.S.T.
First Quarter	11 "	8 P. M.	"
Full Moon	18 "	4 P. M.	"
Last Quarter	24 "	10 P. M.	"

The *Moon* will be farthest from the earth for the month on May 5 and nearest on May 18.

Mercury will be at inferior conjunction with the sun on May 7. It will then be moving westward and will reach a point of greatest elongation west of the sun early in June. It will be visible as a morning star just before sunrise on the last few days of the month.

A transit of Mercury across the face of the sun will take place on May 7 between $9^h\ 44^m$ and $17^h\ 39^m$ Greenwich mean time. For data and diagrams see January number of POPULAR ASTRONOMY, page 40.

Venus, although it will have passed the point of greatest elongation east, will still be very bright in the evening sky. It will attain its maximum brilliancy on May 24. On this date it will be of stellar magnitude —4.2, which means that its light intensity will be about 330 times that of Polaris, and about 11 times that of Sirius, the brightest star in the sky.

Mars will be high enough in the sky for observation in the early morning during the month. It will be near the boundary between Capricornus and Aquarius.

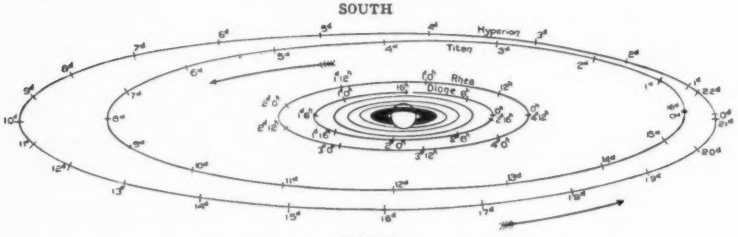
Jupiter will cross the meridian a little after midnight. It will therefore be available for observation before midnight. It will be 22° south of the equator.

Saturn will be very favorably situated for evening observation. At the middle of the month it will cross the meridian just after ten o'clock. It will be a short distance northeast of Spica in the constellation Virgo.

Uranus will be visible in the early morning in the constellation Pisces.

Neptune will still be visible in the west in the early evening. It will be a short distance west of Regulus in the constellation Leo.

Saturn's Satellites.



Apparent orbits of the seven inner satellites of Saturn at date of opposition, April 18, 1924, as seen in an inverting telescope.

[From the *American Ephemeris*.]

CENTRAL STANDARD TIME, NOON = 0^h

I. Mimas. Perod $0^d\ 22^h.6$.

1924	d	h		d	h		d	h		d	h	
May	1	17.3	W	May 9	17.5	E	May 17	6.4	E	May 25	6.6	W
	2	15.9	W	10	16.1	E	18	16.3	W	26	16.6	E
	3	14.5	W	11	14.7	E	19	14.9	W	27	15.2	E
	4	13.1	W	12	13.3	E	20	13.5	W	28	13.8	E
	5	11.7	W	13	11.9	E	21	12.2	W	29	12.4	E
	6	10.3	W	14	10.5	E	22	10.8	W	30	11.0	E
	7	8.9	W	15	9.1	E	23	9.4	W	31	9.6	E
	8	7.5	W	16	7.7	E	24	8.0	W			

II. Enceladus. Period $1^d\ 8^h.9$.

1924	d	h		d	h		d	h		d	h	
May	1	10.6	E	May 9	15.9	E	May 17	21.1	E	May 26	2.4	E
	2	19.5	E	11	0.7	E	19	6.0	E	27	11.3	E
	4	4.4	E	12	9.6	E	20	14.9	E	28	20.2	E
	5	13.2	E	13	18.5	E	21	23.8	E	30	5.1	E
	6	22.1	E	15	3.4	E	23	8.7	E	31	14.0	E
	8	7.0	E	16	12.3	E	24	17.6	E			

III. Tethys. Period $1^d\ 21^h.3$.

May	1	6.5	E	May 10	16.9	E	May 20	3.4	E	May 29	13.9	E
	3	3.8	E	12	14.2	E	22	0.7	E	31	11.2	E
	5	1.1	E	14	11.5	E	23	22.0	E			
	6	22.3	E	16	8.8	E	25	19.3	E			
	8	19.6	E	18	6.1	E	27	16.6	E			

IV. Dione. Period $2^d\ 17^h.7$.

May	4	6.2	E	May 12	7.2	E	May 20	12.1	E	May 28	17.1	E
	6	19.9	E	15	0.8	E	23	5.8	E	31	10.8	E
	9	13.6	E	17	18.5	E	25	23.4	E			

V. Rhea. Period $4^d\ 12^h.5$.

May	2	3.9	E	May 11	4.5	E	May 20	5.2	E	May 29	5.9	E
	6	16.2	E	15	16.8	E	24	17.6	E			

VI. Titan. Period $15^d\ 23^h.3$.

May	4	10.5	W	May 12	9.1	E	May 20	8.0	W	May 28	6.9	E

VII. Hyperion. Period $21^d\ 7^h.6$

May	2	23.4	W	May 14	9.2	E	May 24	2.4	W			

NOTE—E, Eastern Elongation; W, Western Elongation.

Phenomena of Jupiter's Satellites.

VISIBLE AT WASHINGTON.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME, NOON = 0^h

1924	h	m			1924	h	m		
May 30	11	57	II	Sh. I.	May 11	9	11	I	Oc. R.
	11	42	III	Oc. D.	14	11	44.0	II	Ec. D.
	12	42	I	Sh. I		15	9	II	Oc. R.
	13	29	I	Tr. I.	16	9	12	II	Sh. E.
	13	57	III	Oc. R.		10	7	II	Tr. E.
	14	54	I	Sh. E.		13	50.0	I	Ec. D.
	15	40	I	Tr. E.	17	10	58	I	Sh. I.
2	10	2.8	I	Ec. D.		11	25	I	Tr. I.
	12	59	I	Oc. R.		13	10	I	Sh. E.
3	9	22	I	Sh. E.		13	36	I	Tr. E.
	10	6	I	Tr. E.	18	8	18.4	I	Ec. D.
5	14	58	II	Sh. I.		10	55	I	Oc. R.
7	9	8.6	II	Ec. D.	19	8	36	III	Sh. E.
	12	52	II	Oc. R.		10	10	III	Tr. E.
8	12	27.8	III	Ec. D.	21	14	19.8	II	Ec. D.
	14	36	I	Sh. I.	23	9	23	II	Sh. I.
	14	49.1	III	Ec. R.		10	1	II	Tr. I.
	15	6	III	Oc. D.		11	47	II	Sh. E.
	15	15	I	Tr. I.		12	22	II	Tr. E.
9	11	56.3	I	Ec. D.	24	12	52	I	Sh. I.
	14	44	I	Oc. R.		13	10	I	Tr. I.
10	9	5	I	Sh. I.		15	4	I	Sh. E.
	9	41	I	Tr. I.	25	10	12.1	I	Ec. D.
	11	16	I	Sh. E.		12	39	I	Oc. R.
	11	51	I	Tr. E.					

1924	h	m			1924	h	m		
May 26	9	33	I	Sh. E.	May 30	11	57	II	Sh. I.
	9	47	I	Tr. E.		12	15	II	Tr. I.
	10	11	III	Sh. I.		14	21	II	Sh. E.
	11	14	III	Tr. I.		14	36	II	Tr. E.
	12	35	III	Sh. E.	31	14	47	I	Sh. I.
	13	28	III	Tr. E.		14	54	I	Tr. I.

NOTE:—I. denotes ingress; E, egress; D, disappearance; R, reappearance; Ec, eclipse; Oc, occultation; Tr, Transit of the satellite; Sh, transit of the shadow.

Occultations Visible at Washington.

[*From the American Ephemeris*]

Date 1924		Star's Name	Magnitude	IMMERSION. Washington M.T.	IMMERSION. Angle from N	EMERSION. Washington M.T.	EMERSION. Angle from N	Duration
				h m	°	h m	°	h m
May	5	264 B. Tauri	4.8	7 57	140	8 30	212	0 33
	7	19 B. Gemin.	6.2	9 38	91	10 33	278	0 54
	10	54 Cancri	6.3	12 13	84	13 2	304	0 49
	12	45 Leonis	5.8	9 11	69	10 2	341	0 51
	12	49 Leonis	5.7	13 28	147	14 10	251	0 42
	15	48 Virginis	6.5	7 36	185	8 5	231	0 29
	22	π Capricorni	5.2	14 50	146	15 23	193	0 33
	22	ρ Capricorni	5.0	15 33	63	16 54	270	1 21
	26	27 Piscium	5.1	15 48	23	16 41	291	0 53

VARIABLE STARS.

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900		Decl. 1900		Magnitude	Approx. Period		Greenwich mean times of maxima in 1924							
								May							
	h	m	°	′		d	h	d	h	d	h	d	h	d	h
SX Cassiop.	0	05.5	+54	20	8.6— 9.2	36	13.7	3	11						
SY Cassiop.	0	09.8	+57	52	9.3— 9.9	4	01.7	6	6	14	9	22	12	30	16
RR Ceti	1	27.0	+ 0	50	8.3— 9.0	0	13.3	4	23	12	17	20	11	28	5
RW Cassiop.	1	30.7	+57	15	8.9—11.0	14	19.2	8	22			23	17		
V Arietis	2	09.6	+11	46	8.3— 9.0	0	23.8	4	9	12	7	20	6	28	4
SU Cassiop.	2	43.0	+68	28	6.5— 7.0	1	22.8	5	12	13	7	21	2	28	21
RW Camelop.	3	46.2	+58	21	8.2— 9.4	16	00.0	3	18			20	3		
SX Persei	4	10.2	+41	27	10.4—11.2	4	07.0	5	15	14	5	22	19	31	9
SV Persei		42.8	+42	07	8.8— 9.6	11	03.1			12	3			23	6
RX Aurigæ	4	54.5	+39	49	7.2— 8.1	11	15.0	1	19	13	10	25	1		
SX Aurigæ	5	04.6	+42	02	8.0— 8.7	1	12.8	5	22	13	14	21	6	28	22
SY Aurigæ		05.5	+42	41	8.4— 9.5	10	03.3	9	17	19	20	30	0		
Y Aurigæ		21.5	+42	21	8.6— 9.6	3	20.6	5	8	13	1	20	18	28	11
RZ Gemin.	5	56.6	+22	15	9.1—10.0	5	12.7	3	2	14	4	19	17	30	18
RS Orionis	6	16.5	+14	44	8.2— 8.9	7	13.6	5	17	13	6	20	15	28	9
T Monoc.		19.8	+ 7	08	5.7— 6.8	27	00.3			16	12				
RT Aurigæ		23.0	+30	33	5.1— 6.0	3	17.5	7	19	15	6	22	17	30	4
W Gemin.		29.2	+15	24	6.7— 7.5	7	22.0	7	9	15	7	22	5	31	3
ζ Gemin.	6	58.2	+20	43	3.7— 4.3	10	03.7	3	9	13	13	23	16		

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1924							
					May							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
RU Camelop	7 10.9	+69 51	8.5— 9.8	22 06.5			16 10					
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	4 22		12 20		20 19		28 18	
V Carinae	8 26.7	—59 47	7.4— 8.1	6 16.7	5 4		11 21		25 6		31 23	
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	5 11		14 18		24 1			
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	6 1		14 19		23 13			
Z Leonis	9 46.4	+27 22	7.9— 9.6	56 08.7			15 11					
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	4 16		11 11		25 0		31 19	
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	2 12		9 2		22 7		28 22	
S Muscae	12 07.4	—69 36	6.4— 7.3	9 15.8	7 15		17 7		26 22			
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	2 12		10 12		18 11		26 10	
T Crucis	15.9	—61 44	6.8— 7.6	6 17.6	2 2		8 20		22 7		29 1	
R Crucis	18.1	—61 04	6.8— 7.9	5 19.8	4 7		10 3		21 18		27 14	
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	3 13		12 23		22 8		31 17	
W Virginis	13 20.9	— 2 52	8.7—10.4	17 06.5			11 4				28 11	
SS Hydræ	25.0	—23 08	7.4— 8.1	8 04.8	8 5		16 10		24 14			
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	7 10		14 11		21 11		28 12	
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	7 19		16 0		24 6			
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	3 5		14 5		19 17		30 17	
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	5 11		13 0		20 13		28 2	
R Triang.Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	2 9		9 4		22 17		29 12	
S Triang.Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	1 9		7 17		20 8		26 16	
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18.1	7 23		17 18		27 12			
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	3 15		12 11		21 8		30 4	
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	1 4		13 7		19 8		31 11	
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	4 22		11 23		18 23		25 23	
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02.9	8 13						25 16	
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3	3 6		10 21		18 11		26 1	
Y Sagittarii	18 15.5	—18 54	5.4— 6.2	5 18.6	5 0		9 19		21 8		27 3	
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	6 11		13 5		19 23		26 17	
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08.3	5 23		16 7		26 16			
RZ Lyræ	39.9	+32 42	9.9—11.2	0 12.3	4 16		10 19		23 2		29 5	
RT Scuti	18 44.1	—10 30	9.1— 9.7	0 11.9	2 17		8 16		20 14		26 12	
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2	5 23		15 2		24 4			
U Aquilæ	'9 24.0	— 7 15	6.2— 6.9	7 00.6	3 0		10 1		24 2		31 3	
XZ Cygni	19 30.4	+56 10	8.6— 9.3	0 11.2	4 20		11 20		18 20		25 20	
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	5 23		13 22		21 22		29 21	
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	3 3		10 19		18 12		26 5	
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	6 14		13 18		20 23		28 3	
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	4 21		13 6		21 16		30 1	
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	3 11		9 18		22 10		28 17	
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3			15 16					
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	3 16		12 13		21 10		30 7	
UY Cygni	52.3	+30 03	9.6—10.4	0 13.5	1 7		8 1		21 12		28 6	
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	7 15		14 9		21 2		27 19	
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	3 12				18 5			
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	2 0		9 20		17 17		25 13	
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	5 21		12 18		19 16		26 13	
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	4 6		13 2		18 23		28 14	
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	7 13		16 5		24 20			
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	4 4		14 22		20 7		31 0	
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	4 3		15 0		25 22			
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	3 21		10 7		23 3		29 13	
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	1 14		11 13		21 12		31 11	
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	4 2		15 0		20 10		31 8	
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	1 11		12 8		17 18		28 15	
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	6 20		13 3		19 10		25 17	
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	1 19		13 22		26 1			
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	6 4		13 3		20 3		27 3	

Minima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1924							
					May							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8								
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	5 14	13 6	20 22	28 14				
U Cephei	0 53.4	+81 20	7.0— 9.0	1 11.8	1 3	8 15	16 2	23 13				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	1 12	7 15	19 20	25 23				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	1 6	9 19	18 9	26 23				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	5 9	12 6	19 3	25 23				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	6 14	13 18	20 22	28 2				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	5 10	14 5	23 0	31 18				
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	8 3	16 2	24 1	31 23				
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6	3 13							
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	1 5	9 19	18 10	27 1				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	3 12	10 7	23 21	30 16				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	4 6	12 4	20 1	27 23				
RW Tauri	3 57.8	+27 51	7.1— [11	2 18.5	7 1	15 7	23 15	31 22				
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	4 14	12 12	20 9	28 7				
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	5 19		18 23					
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	3 13	9 20	22 10	28 17				
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	3 14	16 0	28 10					
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	6 0	13 16	20 8	26 0				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	7 4	15 8	23 12	31 16				
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	2 1	8 1	20 2	26 3				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	3 21	12 13	21 5	29 21				
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	4 13	14 23	25 9					
SV Gemin.	54.6	+24 28	9.8— [11	4 00.2	4 9	12 9	20 10	28 10				
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	1 14	13 1	18 19	30 6				
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	5 0	10 15	21 19	27 10				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	2 11	10 15	18 20	27 1				
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	3 19	11 10	19 1	26 16				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	9 15		21 20					
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	4 0	11 4	18 9	25 13				
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	3 12	10 8	23 23	30 18				
RY Gemin.	21.7	+15 52	8.9— [10	9 07.2	5 20	16 3	24 11					
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	3 6	9 21	23 2	29 17				
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	8 3	16 12	24 22					
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	1 22	8 8	21 5	27 15				
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	2 1	9 8	23 21	31 4				
X Carinae	8 29.1	—58 53	7.9— 8.7	0 13.0	6 6	14 9	22 12	30 15				
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	9 9	18 21	28 8					
RX Hydrae	9 00.8	— 7 52	9.1—10.5	2 06.8	6 21	13 17	20 13	27 10				
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	3 16	9 14	21 11	27 9				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	2 13	9 7	22 19	29 13				
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	4 11	11 21	19 7	24 17				
SS Carinæ	10 54.2	—61 23	12.2—12.8	3 07.2	4 23	11 14	24 18	31 9				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	7 19	16 14	25 10					
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	6 2	13 10	20 18	28 2				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	7 8	14 3	20 22	27 16				
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	2 5	9 17	17 5	24 18				
RS Can. Ven	13 06.3	+36 28	7.5—12.5	4 19.1	9 5	18 20	28 10					
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	4 21	12 7	19 18	27 4				
SX Hydræ	13 39.0	—26 23	8.6—12.7	2 21.5	6 4	11 23	23 13	29 8				

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1924							
					May							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	7 14	14 14	21 13	28 13				
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	1 21	8 19	22 14	29 12				
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.4	4 12	12 22	21 8	29 18				
SS Libræ	15 43.4	—15 14	9.3—11.5	0 18.4	4 23	12 4	19 9	26 13				
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	3 1	10 9	17 17	25 1				
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	2 8	10 14	18 20	27 3				
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	4 22	13 18	22 14	31 11				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1			17 1					
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	3 19	10 15	23 5	31 0				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	9 21	18 6	26 16					
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	1 18	7 22	20 5	26 9				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	2 20	9 0	21 9	27 13				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	2 22	10 7	17 16	25 1				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	6 1	14 5	22 10	30 14				
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	1 18	9 7	24 9	31 22				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	3 16	11 10	19 4	26 22				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	4 19	12 19	20 19	28 18				
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	1 14	10 2	18 15	27 3				
WY Sagittarii	17 54.9	—23 01	9.5—10.6	4 16.0	3 8	12 16	22 1	31 9				
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	3 14	13 22	19 2	29 10				
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	6 21	14 3	21 9	28 15				
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	7 7	14 5	21 3	28 0				
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2		15 18		30 21				
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	1 0	8 4	22 12	29 16				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	6 22	14 1	21 4	28 6				
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	7 8	15 15	23 23					
RR Draconis	40.8	+62 34	9.3—13	2 19.9	8 18	17 6	25 18					
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	2 5	8 21	22 4	28 19				
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8	10 3	23 1						
U.Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	6 4	13 19	21 11	29 2				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	6 17	14 7	21 20	29 10				
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	1 5	8 10	22 20	30 0				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4		9 17	18 16	27 15				
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	2 13	9 7	22 19	29 14				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	3 12	10 21	18 6	25 14				
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	1 2	11 13	16 19	27 7				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	5 19	12 8	25 9	31 21				
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	5 5	11 6	23 6	29 6				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	6 0	12 15	19 7	25 22				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	3 20	13 0	22 3	31 7				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	4 15	13 1	21 12	29 22				
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	4 20	11 15	25 4	31 23				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	7 19	14 17	21 15	28 12				
V Vulpec	32.3	+26 15	8.2— 9.8	37 19.0				25 15				
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	6 1	14 16	24 6					
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	3 20	13 1	22 5	31 10				
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	1 16	10 15	19 15	28 15				
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	7 8	14 23	22 13	30 3				
RR Vulpec	20 50.5	+27 32	9.6—11.0	5 01.2	3 11	13 14	23 16					
RY Aquarii	21 14.8	—11 14	8.8—10.4	1 23.2	4 16	12 13	20 10	28 6				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	8 8							
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	2 16	12 19	22 22					
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	3 16	14 1	19 6	29 14				
VW Pegasi	51.7	+32 42	10.0—10.6	5 06.4	4 13	15 2	20 8	30 21				
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.4	4 0	11 14	19 2	26 15				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	4 12	12 18	21 0	29 6				

COMET AND ASTEROID NOTES.

New Object Discovered by Reinmuth. — An object of magnitude 13.6, with abnormal motion in declination for an asteroid, was discovered by Reinmuth on plates taken at Königstuhl. The following positions are given in the Copenhagen Circular No. 36.

1924	Königstuhl M.T.	α	δ
Feb. 11	$14^h\ 21^m.7$	$10^h\ 04^m.2$	$+13°\ 23'$
23	7 38.1	9 51.8	+18 23
Mar. 3	13 51.2	9 42.3	+22 09

Object Discovered by Stroobant an Asteroid.—A cablegram from Copenhagen to Harvard College Observatory on March 7 announced the discovery of an 11th magnitude object by Stroobant, of Uccle, Holland. Later a telegram from Yerkes Observatory stated that the object was an asteroid, probably (177) Irma. The object was three hours of right ascension away from opposition to the sun so that the ordinary ephemerides did not give the position of known asteroids in that region of the sky. Irma, however, was of magnitude 11 at the time of its opposition October 12, 1923, and in March, 1924, should have been nearer magnitude 14. The identification is therefore questionable.

The following positions are given in the Copenhagen Circular No. 36:

1924	Uccle Mean Time	α	δ	Observer
Feb. 28	$8^h\ 02^m.5$	$2^h\ 32^m\ 44^s$	$+15°\ 46'.3$	P. Stroobant
Mar. 4	7 45.8	2 41 08	+16 34.9	"
5	7 43.9	2 42 30	+16 44.1	"
6	7 42.9	2 44 00	+16 56.3	"

Ephemeris of Asteroid (132) Aethra. — Mr. F. E. Seagrave sends in the following ephemeris of the rediscovered Watson asteroid (132) Aethra, computed from the elements which were printed on page 182 in the March number of POPULAR ASTRONOMY. Although the asteroid is now far from the earth it may be possible for some one with a powerful telescope to photograph it. Its magnitude will be about 13.5 in May.

EPHEMERIS OF (132) AETHRA.

G. M. T. 1924		α h m s	δ ° ′ ″	Log r	Log Δ
May	1	19 52 51.8	—10 42 34	0.46358	0.39981
	5	19 53 21.0	—10 07 44	0.46564	0.39270
	9	19 53 26.1	— 9 33 18	0.46770	0.38568
	13	19 53 08.0	— 8 59 14	0.46970	0.37877
	17	19 52 27.0	— 8 25 52	0.47172	0.37209

Monthly Report of the American Association of Variable Star Observers, January 20—February 20, 1924.

Both SS Aurigae and U Geminorum have been in the limelight for variable star observers during the past month. The former was found to be rising on February 27th and on the 28th had reached maximum. The interval since the last observed rise was sixty-nine days. U Geminorum was rising, according to observations by Miyajima and Chandra, on February 4th and proved to be a long-type maximum. The last definitely observed maximum of U Geminorum occurred in February, 1923.

VARIABLE STAR OBSERVATIONS, January 20 to February 20, 1924.

January 0 = J. D. 2423785. February 0 = J. D. 2423816.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
000339 V SCULPTORIS—						
	3761.0	9.5	Bl,	3782.0	10.4	Bl.
	3770.0	9.6	Bl,			
001032 S SCULPTORIS—						
	3761.0	7.1	Bl,	3782.9	7.5	Kd,
	3770.0	7.1	Bl,	3785.9	7.5	Kd,
	3782.0	7.3	Bl,	3790.9	7.6	Kd.
001046 X ANDROMEDAE—						
	3772.7	11.3	Lv,	3807.6	12.4	Lv,
	3788.6	11.9	Lv,	3814.6	12.3	Lv,
	3802.6	12.2	Wf,	3817.6	12.7	Wf.
001620 T CETI—						
	3784.9	6.1	Kd,	3794.9	6.2	Kd.
	3788.9	6.1	Kd,			
001726 T ANDROMEDAE—						
	3772.7	12.0	Lv,	3812.1	10.4	Ch,
	3788.6	11.1	Lv,	3813.6	10.0	Lv,
	3794.2	10.9	Ch,	3817.5	10.2	Pt.
	3803.5	10.9	Ie,			
001755 T CASSIOPEIAE—						
	3817.5	11.6	Pt,	3823.6	10.8	B.
	3817.8	11.2	Sg,	3825.6	11.8	Ya.
001838 R ANDROMEDAE—						
	3812.1	12.6	Ch,	3825.6	10.5	Cy,
	3812.5	11.4	Ie,	3826.6	10.1	Sg,
	3816.5	11.4	Cd,	3830.5	10.0	Gb,
	3817.5	11.3	Pt,	3830.6	9.8	Cy,
	3818.6	11.1	B,	3832.5	9.5	Ie.
	3821.1	11.0	Ch,			
001862 S TUCANAE—						
	3782.0	14.0	Bl.			
001909 S CETI—						
	3812.0	12.0	Ch,	3816.5	13.0	Ie.
002546 T PHOENICIS—						
	3782.0	13.2	Bl.			
003179 Y CEPHEI—						
	3803.6	11.0	Br,	3830.8	10.6	Pa.
004047 U CASSIOPEIAE—						
	3772.7	13.1	Lv,	3817.5	8.7	Pt,
	3788.6	12.3	Lv,	3817.6	8.7	Wf,
	3802.6	10.0	Wf,	3817.8	8.5	Sg,
	3807.6	9.8	Lv,	3823.6	8.5	B,
	3813.6	9.3	Lv,	3829.7	8.4	Sg.
	3816.5	8.9	Ie,			
004132a RW ANDROMEDAE—						
	3794.2	11.4	Ch,	3817.5	12.7	Pt.
004435 V ANDROMEDAE—						
	3772.7	12.7	Lv,	3788.6	13.2	Lv.
004533 RR ANDROMEDAE—						
	3804.6	11.2	Wf,	3817.6	12.2	Wf.
004746a RV CASSIOPEIAE—						
	3804.6	11.6	Wf,	3817.6	12.1	Wf,
	3817.5	12.3	Pt,	3829.6	12.7	B.
004958 W CASSIOPEIAE—						
	3817.5	9.6	Pt,	3825.6	9.9	Cg,
	3818.6	9.2	B,	3825.6	9.0	Ya.
005475 U TUCANAE—						
	3761.0	10.9	Bl.	3782.0	9.7	Bl.
	3770.0	10.5	Bl,			
010102 Z CETI—						
	3817.5	13.3	Pt.			
010630 U SCULPTORIS—						
	3761.0	10.5	Bl,	3782.0	11.0	Bl.
	3770.0	10.7	Bl,			
011041 UZ ANDROMEDAE—						
	3804.6	10.2	Wf,	3817.6	10.4	Wf,
	3816.6	10.6	Ie,	3818.6	10.9	B.
011208 S PISCIUM—						
	3824.6	13.2	Y.			
011272 S CASSIOPEIAE—						
	3772.7	11.1	Lv,	3814.6	12.1	Lv,
	3803.6	11.8	Br,	3817.5	12.8	Pt.
	3812.5	12.4	Ie,			
012233a R SCULPTORIS—						
	3784.9	7.5	Kd.			
012350 RZ PERSEI—						
	3823.6	10.2	B.			
012502 R PISCIUM—						
	3761.6	11.5	Lv,	3814.6	13.0	Lv,
	3772.6	11.4	Lv,	3824.6	13.1	Y.
013238 RU ANDROMEDAE—						
	3794.2	10.9	Ch,	3817.6	10.1	Wf,
	3804.6	10.6	Wf,	3818.6	10.2	B,
	3812.1	10.3	Ch,	3825.5	10.0	Ie.
	3817.5	10.3	Pt,			
013338 Y ANDROMEDAE—						
	3817.5	12.9	Pt.			
014958 X CASSIOPEIAE—						
	3817.5	13.8	Pt,	3821.6	12.5	B.
015354 U PERSEI—						
	3815.7	8.4	Sg,	3824.7	8.6	Pt.
	3818.6	8.7	B,	3829.7	9.8	Sg.
	3819.7	8.5	Ca,			
015912 S ARIETIS—						
	3830.5	11.4	Pt.			
021024 R ARIETIS—						
	3743.7	8.0	Lo,	3812.5	12.4	Cy,
	3772.7	8.7	Lv,	3814.6	12.2	Lv,
	3803.5	10.8	Ie,	3825.6	12.4	Lv,
	3808 6	11 7	Kl,	3830.5	12.2	Pt.
021143a W ANDROMEDAE—						
	3785.0	8.9	Nk,	3818.6	10.0	B,
	3787.9	8.9	Nk,	3830.5	10.8	Pt,
	3811.9	10.1	Nk,	3832.5	10.5	Ie.
	3812.6	9.8	Ie,			
021258 T PERSEI—						
	3824.7	8.4	Pt.			
021403 o CETI—						
	3781.0	7.2	Kd,	3809.0	5.2	Mt,
	3782.0	7.1	Kd,	3809.1	5.0	Ch,
	3784.9	6.9	Nk,	3809.9	5.6	Kd,
	3784.9	6.9	Kd,	3809.9	5.1	Kd,
	3785.9	6.9	Nk,	3809.9	5.1	Mt,
	3786.9	6.5	Kd,	3810.5	4.6	Ca,
	3787.1	7.0	Ch,	3810.5	4.7	I,
	3788.9	6.2	Kd,	3812.5	5.1	Cy,
	3789.9	6.1	Kd,	3812.6	4.6	Lf,
	3790.9	6.1	Kd,	3813.5	4.7	I.
	3792.2	6.1	Ch,	3814.1	5.0	Ch,
	3793.0	6.1	Kd,	3814.9	5.0	Mt,
	3793.9	5.9	Kd,	3815.7	5.0	Sg,
	3795.0	6.1	Kd,	3816.0	5.0	Mt,

VARIABLE STAR OBSERVATIONS, January 20 to February 20, 1924—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
021403 o CETI—Continued.				
	3796.0	6.0 Kd,	3816.5	5.2 Cy,
	3796.2	5.6 Ch,	3816.5	4.7 Ca,
	3798.0	5.9 Kd,	3817.1	5.0 Ch,
	3798.9	5.8 Kd,	3817.5	5.2 Cy,
	3800.0	5.8 Kd,	3817.7	4.6 Sg,
	3800.0	6.1 Mt,	3819.5	4.6 I.
	3800.2	5.2 Ch,	3821.1	5.0 Ch,
	3802.1	5.2 Ch,	3821.6	4.7 Lf,
	3802.5	4.9 I,	3824.5	4.7 I,
	3803.0	5.7 Kd,	3824.5	4.8 Ca,
	3803.5	5.1 Cy,	3825.5	4.8 Cy,
	3803.9	5.8 Kd,	3826.5	4.8 Cy,
	3804.1	5.0 Ch,	3827.5	5.0 Ca,
	3805.0	5.7 Kd,	3828.6	4.3 Sg,
	3805.5	4.9 Ca,	3829.5	4.6 I,
	3805.9	5.6 Kd,	3829.5	4.9 Ca,
	3806.5	4.8 I,	3829.6	4.6 Lf,
	3806.9	5.5 Kd,	3830.5	5.0 Pt,
	3807.5	4.8 Cy,	3830.6	5.4 Cy,
	3807.9	5.4 Kd,	3832.5	4.9 Ca,
	3807.9	5.0 Kd,	3834.5	4.6 I,
	3808.5	5.0 Pt,	3836.6	4.4 Lf.
	3808.6	4.8 Lf,		
021558 S PERSEI—				
	3816.1	8.5 Ch,	3824.7	8.3 Pt.
	3818.6	8.5 B,		
022000 R CETI—				
	3816.5	12.3 Ca.		
022150 RR PERSEI—				
	3812.6	11.3 Ie,	3824.6	11.6 Wf.
	3816.6	11.7 Y,	3824.7	11.2 Pt.
022426 R FORNACIS—				
	3761.0	9.0 Bl,	3782.0	9.8 Bl.
	3770.0	9.5 Bl,		
022813 U CETI—				
	3816.5	8.1 Ca,	3824.6	8.1 Y,
	3821.1	7.9 Ch,	3830.5	7.5 Pt.
023133 R TRIANGULI—				
	3761.7	11.6 Lv,	3823.6	8.8 B,
	3772.7	10.8 Lv,	3825.6	8.5 Lv,
	3776.7	10.5 Lv,	3826.6	8.6 Cy,
	3812.5	9.0 Ie,	3830.5	8.1 Pt,
	3812.5	9.0 Cy,	3830.5	8.3 Cy.
	3813.7	9.7 Lv,		
024356 W PERSEI—				
	3766.1	10.3 My,	3812.6	10.3 Cy,
	3771.0	10.3 My,	3814.0	10.2 My,
	3784.9	10.1 Nk,	3820.0	9.9 My,
	3785.9	10.0 Nk,	3823.6	9.1 B,
	3786.9	10.0 Nk,	3824.0	9.8 My,
	3787.9	10.0Nk,	3824.7	9.2 B,
	3793.2	10.1 Nk,	3826.6	10.3 Cy,
	3803.5	9.9 Cy,	3829.0	9.7 My,
	3808.8	9.8 Ca,	3829.7	8.9 Ca,
	3810.0	10.0 My,	3830.6	10.2 Cy.
	3811.1	9.3 Nk,		
025050 R HOROLOGII—				
	3761.0	9.7 Bl,	3782.0	10.8 Bl,
	3770.0	10.2 Bl,		
025751 T HOROLOGII—				
	3761.0	11.0 Bl,	3782.1	12.6 Bl.
	3770.0	11.8 Bl,		
031401 X CETI—				
	3809.6	8.8 Br,	3824.7	8.9 Pt,
	3816.5	8.9 Ca,	3827.5	8.8 Ca,
	3817.7	9.1 Wf,	3831.2	8.7 B.
	3824.6	9.0 Wf,		
032043 Y PERSEI—				
	3784.9	9.3 Nk,	3793.1	9.3 Nk,
	3785.9	9.3 Nk,	3811.0	9.1 Nk,
	3786.9	9.4 Nk,	3817.5	9.6 Ya,
	3787.9	9.3 Nk,	3824.7	9.0 Pt.
032335 R PERSEI—				
	3809.6	13.0 Br,	3824.7	13.0 Pt.
032443 NOVA PERSEI #2—				
	3793.2	14.3 Nk,	3811.1	14.4 Nk.
042215 W TAURI—				
	3766.1	10.6 My,	3814.0	9.8 My,
	3777.1	10.5 My,	3818.7	9.6 Cy,
	3799.6	10.4 Cy,	3820.1	8.9 My,
	3808.5	9.7 Cy,	3823.6	9.5 B,
	3808.6	10.2 Kl,	3824.0	8.9 My,
	3809.7	10.0 Br,	3824.6	10.0 Kl,
	3810.0	10.2 My,	3824.7	9.0 Pt,
	3812.0	10.1 My,	3825.6	9.5 Cy,
	3813.1	9.9 My,	3825.8	10.0 Sg,
	3813.8	10.2 Sg,	3829.0	8.9 My.
043065 T CAMELOPARDALIS—				
	3824.7	12.8 Pt.		
043208 RX TAURI—				
	3762.7	13.3 Lv,	3813.6	12.0 Lv,
	3788.7	12.9 Lv,	3818.6	11.7 B,
	3809.7	12.5 Br,	3825.6	11.5 Lv.
043263 R RETICULI—				
	3782.1	12.2 Bl.		
043274 X CAMELOPARDALIS—				
	3823.6	8.5 B,	3824.7	9.0 Pt.
043562 R DORADUS—				
	3782.1	5.2 Bl.		
043738 R CAELI—				
	3761.0	11.8 Bl,	3782.1	11.5 Bl.
	3770.1	11.7 Bl,		
044349 R PICTORIS—				
	3761.0	7.8 Bl,	3782.1	8.0 Bl.
	3770.0	7.5 Bl,		
044617 V TAURI—				
	3818.7	13.8 B.		
045307 R ORIONIS—				
	3809.7	12.0 Br,	3818.7	12.6 B.
045514 R LEPORIS—				
	3798.0	8.0 Ch,	3824.6	8.4 Ly.
	3808.6	7.7 Ca,	3829.7	7.9 B,
	3811.2	7.5 Nk,	3830.5	7.5 Pt.
	3823.8	8.0 Ca,		
050003 V ORIONIS—				
	3816.5	12.1 Ie,	3827.4	11.8 Br,
	3817.2	12.2 Ch,	3830.5	11.5 Pt.
	3823.7	12.1 B,		

VARIABLE STAR OBSERVATIONS, January 20 to February 20, 1924—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
050022 T LEPORIS—				
	3761.0	8.8 Bl,	3831.5	8.0 B,
	3770.0	8.7 Bl,	3850.5	8.0 Pt.
	3782.1	8.2 Bl,		
050848 S PICTORIS—				
	3761.0	8.3 Bl,	3782.1	8.0 Bl.
	3770.0	8.0 Bl.		
050953 R AURIGAE—				
	3808.8	9.2 Ca,	3823.8	8.6 Ca,
	3815.5	8.7 Pt,	3825.7	8.8 Lv,
	3816.5	9.0 Ie,	3829.7	8.4 B,
	3821.6	8.8 Br,	3832.7	8.6 Ca.
051247 T PICTORIS—				
	3782.1	11.6 Bl.		
051533 T COLUMBAE—				
	3761.0	11.7 Bl,	3782.1	12.3 Bl.
	3770.0	11.8 Bl,		
052034 S AURIGAE—				
	3813.8	10.4 Sg,	3825.8	10.4 Sg,
	3815.5	10.3 Pt,	3829.7	9.5 B.
	3817.2	10.6 Ch,		
052404 S ORIONIS—				
	3807.5	10.0 Pt,	3824.7	10.5 Br,
	3814.6	10.8 B,	3827.5	11.1 Ca,
	3815.5	10.3 Pt,	3829.6	10.3 B,
	3816.6	10.3 Ca,	3830.5	10.5 Pt.
053005a T ORIONIS—				
	3729.7	10.0 Sg,	3815.5	9.8 Pt,
	3793.1	11.2 Nk,	3815.8	10.0 Sg,
	3800.6	10.3 B,	3817.5	10.7 B,
	3806.5	10.5 Pt,	3817.5	10.1 Pt,
	3807.5	10.4 Pt,	3824.5	10.3 Pt,
	3808.5	10.2 Pt,	3826.8	9.9 Pt,
	3810.5	10.3 Pt,	3829.6	10.2 B.
	3811.0	10.3 Nk,	3830.5	10.0 Pt.
	3811.5	9.8 Pt,	3831.5	10.1 Pt.
053068 S CAMELOPARDALIS—				
	3815.5	9.8 Pt.		
053337 RU AURIGAE—				
	3824.7	11.7 Br,	3826.7	11.4 Sg.
053531 U AURIGAE—				
	3815.5	13.2 Pt,	3823.6	13.0 B.
054319 SU TAURI—				
	3762.7	9.6 Lv,	3817.5	9.6 Pt,
	3806.5	9.5 Pt,	3817.7	9.4 Wf,
	3807.5	9.5 Pt,	3818.5	9.5 B,
	3808.5	9.5 Pt,	3821.6	9.5 Br,
	3809.6	9.5 Br,	3824.5	9.6 Pt.
	3810.5	9.5 Pt,	3824.6	9.5 Br,
	3811.5	9.6 Pt,	3824.6	9.2 Wf,
	3813.7	9.5 Lv,	3825.7	9.6 Lv,
	3814.5	9.5 Cd,	3826.8	9.6 Pt,
	3815.5	9.6 Pt,	3830.5	9.5 Pt,
	3816.5	9.5 Ie,	3831.5	9.5 Pt.
	3817.2	9.7 Ch,		
054615a Z TAURI—				
	3816.6	14.0 Ie.		
054615b RS TAURI—				
	3825.6	9.2 Y.		
054615c RU TAURI—				
	3816.6	10.5 Ie,	3825.6	10.5 Y,
054920a U ORIONIS—				
	3772.7	10.7 Lv,	3816.5	9.8 Hm,
	3784.9	9.4 Nk,	3816.7	10.4 Ca,
	3785.9	9.3 Nk,	3817.2	10.7 Ch,
	3786.9	9.4 Nk,	3817.8	10.7 Sg,
	3787.9	9.4 Nk,	3824.6	11.0 Kl,
	3793.2	9.8 Nk,	3825.6	11.2 Cy,
	3799.5	9.4 Cy,	3825.7	10.9 Lv,
	3808.6	11.0 Kl,	3826.7	10.0 Gb,
	3811.1	10.5 Nk,	3829.7	10.1 B,
	3812.6	10.6 Cy,	3829.7	10.5 Ca,
	3813.7	10.7 Lv,	3830.7	11.2 Cy.
	3815.5	10.8 Pt,		
054920b UW ORIONIS—				
	3799.5	9.4 Cy,	3825.6	10.5 Cy,
	3812.6	10.5 Cy,	3825.7	10.6 Lv,
	3813.7	10.6 Lv,	3830.7	10.5 Cy.
055353 Z AURIGAE—				
	3771.1	10.6 My,	3823.5	9.8 B,
	3793.1	10.4 Ch,	3824.0	9.7 My,
	3810.1	9.7 My,	3824.6	9.7 Wf,
	3812.1	9.7 My,	3824.8	10.0 Pt.
	3814.0	9.8 My,	3829.1	9.7 My,
	3817.5	9.8 B,	3829.7	9.8 B,
	3817.7	10.0 Wf,	3830.5	9.6 Pt.
	3820.1	9.7 My,		
055686 R OCTANTIS—				
	3761.0	8.2 Bl,	3782.1	8.6 Bl.
	3770.0	8.0 Bl,		
060450 X AURIGAE—				
	3816.6	10.4 Ie.	3829.7	11.2 B.
	3824.8	10.6 Pt,		
060547 SS AURIGAE—				
	3787.1	[11.6 Ch,	3816.5	[13.3 Ie.
	3788.1	[11.6 Ch,	3816.7	[12.4 Cy.
	3791.1	[11.4 Ch,	3817.5	[13.8 B,
	3792.2	[11.6 Ch,	3817.5	[12.6 B,
	3793.2	[11.6 Ch,	3817.6	[13.3 Wf,
	3802.6	[13.3 Wf,	3818.6	[12.6 Br,
	3803.6	[12.4 Br,	3818.6	[13.9 Wf,
	3806.5	[12.0 Pt,	3821.2	[12.4 Ch,
	3807.5	[12.4 Pt,	3821.6	[13.3 Br,
	3808.0	[11.0 Ch,	3823.5	[13.7 B,
	3808.5	[12.6 Pt,	3824.5	[12.6 Kl,
	3808.6	[12.6 Kl,	3824.5	[12.6 Pt,
	3808.7	[13.3 Sg,	3824.6	[13.3 Br,
	3809.1	[11.6 Ch,	3824.6	[14.9 Wf,
	3809.6	[13.3 Br,	3825.5	[13.3 Ie,
	3810.5	[12.6 Pt,	3825.6	[11.8 Cy,
	3811.1	[11.0 Ch,	3825.7	[13.3 Lv,
	3811.1	14.8 Nk.	3826.5	[13.3 Kl,
	3811.5	[13.3 Ie,	3826.6	[11.6 Cy,
	3811.5	[12.6 Pt,	3826.8	[12.6 Pt,
	3811.5	[12.6 Kl,	3829.5	[12.6 Ie.
	3812.1	[11.6 Ch,	3829.7	[13.3 B.
	3812.5	[13.3 Ie,	3830.5	[12.6 Pt,
	3812.5	[13.3 Cd,	3830.6	[12.4 Cy,
	3812.6	[12.4 Cy,	3830.8	[15.0 Pa,
	3814.2	[11.6 Ch,	3831.5	[12.4 Ie,
	3814.7	[13.9 Lv,	3831.5	[12.6 Pt,
	3815.5	[11.8 Kl,	3831.5	[12.6 Pt.
	3815.5	[12.4 Pt.		

VARIABLE STAR OBSERVATIONS, January 20 to February 20, 1924—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
061647 V AURIGAE—						
	3825.7	11.0	B.			
061702 V MONOCEROTIS—						
	3810.1	11.6	Ch,	3824.8	11.2	Pt.
	3824.7	11.0	Br,			
063159 U LYNCIS—						
	3816.6	9.8	Y.			
063308 R MONOCEROTIS—						
	3817.6	11.5	B,	3824.8	11.5	Pt,
	3824.7	11.6	Br,	3829.5	11.7	B.
063558 S LYNCIS—						
	3824.8	12.6	Pt.			
064707 W MONOCEROTIS—						
	3818.6	10.3	B,	3824.8	11.3	Pt.
065111 Y MONOCEROTIS—						
	3772.7	10.6	Lv,	3816.6	9.0	Y,
	3812.1	9.4	Ch,	3824.8	9.7	Pt,
	3813.7	9.3	Lv,	3827.7	9.8	Lv.
065208 X MONOCEROTIS—						
	3805.1	8.4	Ch,	3824.6	8.2	Ca.
	3810.7	8.1	Ca,			
070109 V CANIS MINORIS—						
	3812.6	12.4	Ie.			
070122a R GEMINORUM—						
	3769.7	7.6	Pa,	3826.7	8.9	Pa,
	3771.7	7.8	Pa,	3826.8	8.8	Pt,
	3808.8	8.1	Ca,	3827.7	8.4	Lv,
	3812.6	8.3	Ie,	3829.5	8.5	Al,
	3814.7	8.8	Lv,	3829.6	9.0	Ya,
	3815.5	8.8	Al,	3829.6	8.8	B,
	3817.6	8.5	B,	3829.8	8.5	Ca,
	3821.5	8.7	B,	3837.6	8.5	Al.
	3825.8	9.0	Sg,			
070122b Z GEMINORUM—						
	3812.6	12.2	Ie,	3826.8	12.6	Pt,
	3814.7	12.5	Lv,	3827.7	12.4	Lv,
	3817.6	12.4	B,	3829.6	12.3	B.
	3823.5	12.4	B,			
070122c TW GEMINORUM—						
	3808.8	8.3	Ca,	3826.8	8.0	Pt,
	3814.7	8.4	Lv,	3827.7	8.3	Lv,
	3817.6	8.3	B,	3829.6	8.0	B,
	3824.5	8.1	B,	3829.8	8.0	Ca.
071201 RR MONOCEROTIS—						
	3772.8	12.1	Lv,	3827.8	13.5	Lv.
	3813.7	13.4	Lv,			
072708 S CANIS MINORIS—						
	3800.1	10.9	Ch,	3821.6	9.7	B,
	3808.0	10.2	Ch,	3825.7	9.5	Cy,
	3812.6	10.2	Cy,	3826.8	9.4	Pt,
	3816.6	10.0	Cd,	3827.5	9.3	Ca,
	3817.7	10.0	Sg,	3829.6	9.5	Ie.
072811 T CANIS MINORIS—						
	3826.8	13.5	Pt.			
073173 S VOLANTIS—						
	3761.0	9.1	Bl,	3782.8	8.8	Bl,
	3770.0	8.9	Bl,			
073508 U CANIS MINORIS—						
	3816.6	9.2	Y,	3826.8	8.5	Pt.
	3821.6	8.6	B,			
073723 S GEMINORUM—						
	3817.6	13.8	B.			
074241 W PUPPIS—						
	3761.0	8.7	Bl,	3782.1	9.2	Bl.
	3770.0	8.7	Bl,			
074922 U GEMINORUM—						
	3772.8	[13.8	Lv,	3818.2	[12.4	Ch,
	3787.1	[12.3	Ch,	3818.6	[13.7	Wf,
	3788.1	[11.7	Ch,	3820.1	11.8	My,
	3789.2	[11.7	Ch,	3821.0	10.0	Ch,
	3791.1	[11.4	Ch,	3821.6	9.5	B,
	3792.2	[12.3	Ch,	3821.6	9.2	Br,
	3793.1	[12.4	Ch,	3823.5	9.4	B,
	3795.2	[12.3	Ch,	3823.6	8.7	Cd,
	3796.2	[12.3	Ch,	3824.1	8.7	My,
	3798.0	[10.3	Ch,	3824.5	9.1	Kl,
	3799.9	[12.4	Cy,	3824.6	8.9	Kl,
	3800.1	[10.9	Ch,	3824.6	9.7	Cd,
	3801.1	[10.5	Ch,	3824.6	9.3	Br,
	3802.1	[10.9	Ch,	3824.7	9.2	Pt,
	3803.4	[12.4	Ch,	3824.7	9.0	Wf,
	3804.1	[10.3	Ch,	3825.5	9.6	Ie.
	3804.6	[12.4	Wf,	3825.5	9.3	Cd,
	3807.5	[10.9	Pt,	3825.6	9.0	Y,
	3808.0	[10.3	Ch,	3825.7	9.4	Cy,
	3808.5	[12.4	Pt,	3826.5	9.0	Kl,
	3808.6	[12.6	Kl,	3826.6	9.1	Cy,
	3809.1	[10.3	Ch,	3826.8	9.6	Pt,
	3810.1	[12.3	Ch,	3827.5	9.7	Cd,
	3810.5	[12.4	Pt.	3827.5	9.1	Y,
	3811.1	[11.7	Ch,	3827.5	10.0	Ie,
	3811.5	[12.6	Kl,	3827.7	9.2	Lv,
	3811.5	[12.4	Pt,	3829.1	9.1	My,
	3811.5	[13.3	Ie,	3829.5	9.7	Ie,
	3812.1	[12.4	Ch,	3829.5	9.2	Ca,
	3812.7	[13.7	Ie,	3829.5	9.8	B,
	3812.7	[12.4	Cy,	3829.6	9.7	Cd,
	3814.1	[12.4	Ch,	3829.6	9.5	Ya,
	3814.1	[12.6	My,	3830.5	10.0	Pt,
	3815.1	[12.3	Ch,	3830.5	9.7	Cd,
	3815.5	[12.4	Kl,	3830.5	9.4	Cy,
	3815.5	[11.2	Pt,	3830.6	9.9	B,
	3816.1	[12.3	Ch,	3830.7	9.5	Lv,
	3816.5	[13.7	Ie,	3831.5	10.1	Pt,
	3816.6	[13.3	Y,	3831.5	9.7	Ie,
	3816.7	[13.8	Lv,	3831.6	10.0	B,
	3816.7	[12.4	Cy,	3831.8	9.5	M,
	3817.1	[12.4	Ch,	3832.5	10.0	Ie,
	3817.5	[13.8	B,	3832.5	10.3	Cd,
	3817.5	[13.7	Pt,	3834.6	11.0	Cd.
	3817.6	[13.3	Wf,			
075612 U PUPPIS—						
	3814.8	14.8	Pa.			
081112 R CANCRI—						
	3803.4	9.3	Ch,	3815.1	8.6	Ch,
	3821.6	8.7	B,	3826.8	8.3	Pt,
	3812.6	8.7	Ie,	3829.7	8.6	Kl.
081617 V CANCRI—						
	3817.6	10.6	B,	3826.8	9.4	Pt.
082405 RT HYDRAE—						
	3817.7	8.1	B,	3826.8	8.0	Pt.

VARIABLE STAR OBSERVATIONS, January 20 to February 20, 1924—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
083019 U CANCRI—				
	3814.8	13.5 Pa,	3827.7	12.4 Lv,
	3824.7	12.5 Wf,	3830.8	10.7 Pa.
083350 X URSAE MAJORIS—				
	3825.6	10.8 Cg,	3829.6	11.5 B.
	3826.8	11.5 Pt,		
084803 S HYDRAE—				
	3826.8	12.4 Pt.		
085008 T HYDRAE—				
	3789.2	8.5 Ch,	3817.6	9.6 B,
	3815.2	9.3 Ch,	3826.8	9.8 Pt.
085120 T CANCRI—				
	3789.2	8.3 Ch,	3826.8	7.9 Pt.
	3817.7	8.3 B,		
090024 S PYXIDIS—				
	3826.8	12.2 Pt.		
090425 W CANCRI—				
	3818.6	8.2 Wf,	3824.7	8.1 Wf.
092962 R CARINAE—				
	3761.0	5.5 Bl,	3782.1	4.2 Bl.
	3770.0	4.5 Bl,		
093014 X HYDRAE—				
	3817.7	12.2 B,	3826.8	12.2 Pt.
093934 R LEONIS MINORIS—				
	3787.1	10.8 Ch,	3826.8	9.3 B,
	3812.1	9.9 Ch,	3840.6	8.1 Al.
	3817.7	9.5 B,		
094211 R LEONIS—				
	3787.1	10.0 Ch,	3826.8	9.3 Pt,
	3799.9	9.9 Cy,	3829.6	10.0 Al,
	3812.7	10.2 Cy,	3829.6	9.5 B,
	3814.2	10.3 Ch,	3829.8	9.5 Sg,
	3815.8	10.2 Sg,	3830.7	10.2 Cy,
	3816.6	10.3 Ca,	3831.8	10.0 M,
	3824.6	11.0 Ly,	3832.6	9.9 Ca.
	3824.8	10.2 Cy,		
094622 Y HYDRAE—				
	3826.8	6.4 Pt.		
094953 Z VELORUM—				
	3761.0	10.0 Bl,	3782.1	10.9 Bl.
	3770.0	10.3 Bl,		
095421 V LEONIS—				
	3824.7	10.5 Wf,	3826.8	10.7 Pt.
100661 S CARINAE—				
	3761.0	6.7 Bl,	3782.1	7.7 Bl.
	3770.0	6.9 Bl.		
101153 W VELORUM—				
	3761.0	9.7 Bl,	3782.1	10.7 Bl.
	3770.0	10.3 Bl,		
103212 U HYDRAE—				
	3788.4	5.4 Kd,	3800.4	5.4 Kd.
	3795.4	5.4 Kd,		
103769 R URSAE MAJORIS—				
	3808.6	11.9 Kl,	3826.8	9.4 Pt,
	3812.6	11.7 Ie,	3829.7	9.4 Sg,
	3815.7	11.3 Sg,	3829.9	9.7 Cd,
	3812.5	11.4 Cd,	3831.8	9.6 M,
	3823.5	10.3 Ca,	3832.5	9.3 Ly,
	3824.5	10.1 Kl,	3834.5	9.1 Ly.
104620 V HYDRAE—				
	3770.9	9.1 Bl,	3803.4	10.3 Ch,
	3782.1	9.4 Bl,	3826.8	8.5 Pt.
104628 RS HYDRAE—				
	3770.1	13.2 Bl.		
104814 W LEONIS—				
	3826.8	12.9 Pt.		
110506 S LEONIS—				
	3826.8	12.2 Pt.		
111661 RS CENTAURI—				
	3761.0	10.3 Bl,	3782.1	11.9 Bl.
	3770.0	10.8 Bl.		
114441 X CENTAURI—				
	3770.1	9.7 Bl,	3782.1	10.7 Bl.
115058 W CENTAURI—				
	3770.1	13.2 Bl.		
115919 R COMAE BERENICES—				
	3814.8	14.5 Pa,	3830.8	14.0 Pa.
120012 SU VIRGINIS—				
	3826.8	13.2 Pt.		
121418 R CORVI—				
	3826.8	8.9 Pt.		
122001 SS VIRGINIS—				
	3779.4	7.8 Kd,	3793.4	8.1 Kd.
	3786.0	7.9 Kd,	3800.3	8.1 Kd.
122532 T CANUM VENATICORUM—				
	3826.8	9.6 Pt.		
123160 T URSAE MAJORIS—				
	3799.9	7.2 Cy,	3824.6	6.8 Ly,
	3808.6	7.2 Ca,	3824.8	6.9 Cy,
	3808.6	6.3 Kl,	3825.6	7.9 Cg,
	3810.6	7.3 Ly,	3826.7	6.7 Sg,
	3812.5	7.7 Cd,	3826.8	7.2 Pt.
	3812.6	7.0 Ly,	3827.5	6.9 Ca,
	3812.7	6.4 Ie,	3829.5	6.9 Ly,
	3812.7	7.1 Cy,	3830.7	6.5 Cy,
	3816.6	7.2 Ca,	3831.5	6.6 Ly,
	3816.6	6.8 Ly,	3832.5	6.9 Cd,
	3823.5	6.9 Ca,	3832.5	6.9 Ca,
	3824.5	7.4 Kl,	3834.5	6.8 Ly.
123307 R VIRGINIS—				
	3808.8	7.4 Ca,	3826.8	8.1 Pt,
	3816.7	7.7 Ca,	3828.7	8.1 Ca.
	3823.7	7.9 Ca.		
123459 RS URSAE MAJORIS—				
	3811.1	13.0 Nk,	3824.7	13.5 Wf,
	3812.5	12.7 Cd,	3826.8	14.0 Pt,
	3814.3	12.0 Ch,	3829.9	13.4 Cd.
123961 S URSAE MAJORIS—				
	3800.0	8.4 Cy,	3824.8	8.3 Cy,
	3808.6	7.5 Ca,	3825.6	7.9 Cg,
	3810.6	8.3 Ly,	3825.8	7.5 Sg,
	3812.5	7.7 Cd,	3826.8	8.0 Pt,
	3812.6	8.1 Ly,	3827.5	7.8 Ca,
	3812.6	7.8 Cg,	3829.5	8.1 Ly,
	3812.7	8.3 Cy,	3830.8	8.3 Cy,
	3813.8	7.6 Sg,	3831.5	8.1 Ly,
	3816.6	8.2 Ly,	3832.5	7.9 Cd,
	3816.6	7.7 Ca,	3832.6	8.1 Ca,
	3823.5	7.8 Ca,	3834.5	8.3 Ly.
	3824.6	8.1 Ly,		

VARIABLE STAR OBSERVATIONS, January 20 to February 20, 1924—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
124204 RU VIRGINIS—						
	3826.8	11.8	Pt.			
124606 U VIRGINIS—						
	3826.8	9.8	Pt.			
130212 RV VIRGINIS—						
	3824.9	10.6	Wf.			
131283 U OCTANTIS—						
	3761.0	9.0	Bl,	3782.1	9.8	Bl.
	3770.1	8.9	Bl.			
132262 RR URSAE MAJORIS—						
	3807.9	8.9	Ml.			
132422 R HYDRAE—						
	3770.2	7.0	Bl,	3793.4	7.3	Kd,
	3782.1	7.0	Bl,	3798.4	7.3	Kd,
	3779.4	7.5	Kd,	3800.3	7.3	Kd,
	3783.4	7.5	Kd,	3803.3	7.3	Kd,
	3786.3	7.3	Kd,	3809.4	7.3	Kd,
	3788.4	7.4	Kd,	3830.9	6.0	Pt.
	3791.4	7.4	Kd,			
132706 S VIRGINIS—						
	3779.9	10.5	Cy,	3828.7	9.8	Ca,
	3816.9	10.3	Cy,	3830.8	9.3	Cy,
	3821.3	10.0	Ch,	3830.9	9.8	Pt.
	3824.9	10.0	Cy,			
133155 RV CENTAURI—						
	3770.2	9.0	Bl,	3782.1	9.2	Bl.
133273 T URSAE MINORIS—						
	3724.8	12.4	Wf.			
133633 T CENTAURI—						
	3770.2	5.8	Bl,	3793.4	6.7	Kd,
	3782.1	6.0	Bl,	3795.4	6.7	Kd,
	3783.4	6.1	Kd,	3800.3	6.9	Kd,
	3786.3	6.1	Kd,	3803.3	7.2	Kd,
	3788.4	6.3	Kd,	3809.4	7.2	Kd.
	3791.4	6.6	Kd,			
134236 RT CENTAURI—						
	3770.2	11.4	Bl,	3782.1	11.6	Bl.
134327 W HYDRAE—						
	3807.9	7.4	Ml.			
134440 R CANUM VENATICORUM—						
	3830.9	8.1	Pt.			
134536 RX CENTAURI—						
	3770.2	11.5	Bl,	3782.1	11.6	Bl.
135908 RR VIRGINIS—						
	3830.9	12.5	Pt.			
140512 Z VIRGINIS—						
	3830.9	10.6	Pt.			
140959 R CENTAURI—						
	3770.2	7.0	Bl,	3782.1	7.4	Bl.
141567 U URSAE MINORIS—						
	3803.5	8.4	Ch,	3830.9	8.2	Pt,
	3825.6	9.0	Cg,	3831.8	8.6	M.
141954 S BOOTIS—						
	3817.2	8.0	Sg,	3830.9	8.5	Pt.
	3829.8	8.6	Sg,			
142539 V BOOTIS—						
	3799.9	11.0	Cy,	3828.7	11.0	Ca,
	3812.7	11.3	Cy,	3830.7	11.0	Cy,
	3824.8	11.1	Cy,	3830.9	8.8	Pt.
142584 R CAMELOPARDALIS—						
	3808.7	9.7	Ca,	3830.9	10.8	Pt.
143227 R BOOTIS—						
	3830.9	12.5	Pt,	3831.9	12.4	Ie.
	3831.8	11.7	M,			
144918 U BOOTIS—						
	3831.8	11.4	M.			
145971 S APODIS—						
	3761.0	10.0	Bl,	3782.1	10.2	Bl.
	3770.2	10.2	Bl,			
150018 RT LIBRAE—						
	3830.9	11.5	Pt.			
150519 T LIBRAE—						
	3830.9	13.2	Pt.			
151520 S LIBRAE—						
	3801.5	9.2	Ch.			
151714 S SERPENTIS—						
	3824.8	12.9	Wf,	3830.9	12.8	Pt.
151723 RW LIBRAE—						
	3807.9	8.5	Ml.			
151731 S CORONAE BOREALIS—						
	3808.8	7.3	Ca,	3829.8	7.7	Ca.
	3816.8	7.6	Ca,			
152714 RU LIBRAE—						
	3830.9	9.1	Pt.			
152849 R NORMAE—						
	3770.2	7.9	Bl.			
163378 S URSAE MINORIS—						
	3786.0	11.0	Nk,	3819.7	9.9	Ca,
	3800.0	10.4	Cy,	3824.8	9.5	Cy.
	3811.1	9.8	Nk,	3829.7	8.6	Sg,
	3812.7	9.7	Cy,	3830.7	9.6	Cy,
	3815.7	9.5	Sg,	3830.9	8.8	Pt.
154428 R CORONAE BOREALIS—						
	3783.4	6.2	Kd,	3816.8	6.0	Ca,
	3787.4	6.3	Kd,	3817.0	6.3	Cy,
	3799.9	6.3	Cy,	3821.5	6.2	Ch,
	3800.3	6.3	Kd,	3831.9	6.2	Pt,
	3801.5	6.1	Ch,	3823.8	6.1	Ca.
	3803.0	6.3	Cy,	3824.8	6.4	Wf,
	3803.5	6.2	Ch,	3824.8	6.3	Cy,
	3806.0	6.3	Cy,	3826.9	6.3	Cy,
	3806.9	6.3	Cy,	3827.9	5.8	Cd,
	3807.4	6.2	Kd,	3828.7	6.2	Ca,
	3807.9	6.2	Pt,	3828.9	6.3	Cy,
	3808.8	6.3	Ca,	3829.8	6.1	Ca,
	3808.8	6.3	Cy,	3829.8	6.5	Gb,
	3812.8	6.3	Cy,	3830.8	6.3	Cy,
	3814.9	6.3	Cy,	3830.9	6.2	Pt,
	3814.8	6.2	Pt,	3831.8	6.2	M,
	3815.1	6.0	Cd,	3831.8	6.3	Ie,
	3816.8	6.2	Pt,	3832.7	6.1	Ca.
154536 X CORONAE BOREALIS—						
	3824.8	12.6	Wf.			
154615 R SERPENTIS—						
	3802.5	7.9	Ch,	3823.8	6.9	Ca,
	3808.8	7.3	Ca,	3829.8	6.7	Ca,
	3816.8	7.0	Ca,	3830.9	6.4	Pt.
154639 V CORONAE BOREALIS—						
	3816.8	8.1	Ca,	3830.9	8.3	Pt.
	3824.8	9.1	Wf,			
155018 RR LIBRAE —						
	3801.5	8.8	Ch,	3830.9	9.0	Pt.

VARIABLE STAR OBSERVATIONS, January 20 to February 20, 1924—Continued.

Star J.D. Est.Obs. J.D. Est.Obs.

155823 RZ SCORPII—
3830.9 10.0 Pt.

160118 R HERCULIS—
3801.5 9.0 Ch, 3830.9 9.7 Pt.

160210 U SERPENTIS—
3799.9 9.2 Cy, 3824.9 10.4 Cy,
3814.9 9.8 Cy, 3830.9 10.0 Pt.

160625a RU HERCULIS—
3824.9 13.0 Wf, 3830.9 13.3 Pt.

160625b SX HERCULIS—
3807.9 7.8 Pt, 3830.9 7.8 Pt,
3824.9 8.0 Wf, 3831.9 7.8 Pt.
3826.9 7.8 Pt,

161122b S SCORPII—
3830.9 11.8 Pt.

161607 W OPHIUCHI—
3830.9 11.3 Pt.

162112 V OPHIUCHI—
3830.9 9.7 Pt.

162119 U HERCULIS—
3816.9 10.2 Ca, 3831.9 9.9 Ie.
3831.8 9.8 M,

162807 SS HERCULIS—
3830.9 10.2Pt.

162815 T OPHIUCHI—
3830.9 12.0 Pt.

163137 W HERCULIS—
3801.5 10.2 Ch, 3830.9 12.0 Pt.
3831.8 10.5 M,

163172 R URSAE MINORIS—
3831.8 9.7 M.

163266 R DRACONIS—
3807.5 11.1 Ch, 3831.8 10.1 M.
3830.9 10.2 Pt,

164319 RR OPHIUCHI—
3830.9 10.7 Pt.

164715 S HERCULIS—
3830.9 12.4 Pt.

165202 SS OPHIUCHI—
3830.9 9.1 Pt.

165631 RV HERCULIS—
3830.9 11.5 Pt, 3831.8 11.8 M.

170215 R OPHIUCHI—
3831.9 12.7 Ie.

171401 Z OPHIUCHI—
3816.9 8.3 Ca, 3830.9 8.5 Pt.

171723 RS HERCULIS—
3824.9 8.6 Wf, 3831.8 8.3 M.
3830.9 8.5 Pt.

172486 S OCTANTIS—
3770.2 13.4 Bl.

172809 RU OPHIUCHI—
3830.9 9.0 Pt.

175111 RT OPHIUCHI—
3830.9 12.6 Pt.

175519 RY HERCULIS—
3803.5 10.8 Ch, 3830.9 12.2 Pt.

175654 V DRACONIS—
3830.9 9.9 Pt.

180531 T HERCULIS—
3803.5 11.2 Ch, 3830.9 8.6 Pt,
3816.9 9.5 Ca, 3831.8 8.0 M,
3823.9 9.0 Ca, 3831.9 8.6 Ie.

180565 W DRACONIS—
3830.9 11.6 Pt.

180666 X DRACONIS—
3830.9 11.5 Pt.

180911 NOVA OPHIUCHI #4—
3830.9 13.5 Pt.

181103 RY OPHIUCHI—
3830.9 8.2 Pt.

181136 W LYRAE—
3816.8 8.2 Ca, 3830.9 8.0 P.,
3823.9 8.2 Ca, 3831.9 7.7 M.

182306 T SERPENTIS—
3830.9 10.6 Pt.

183308 X OPHIUCHI—
3830.9 6.5 Pt.

184134 RY LYRAE—
3830.9 10.4 Pt.

184205 R SCUTI—
3827.0 5.0 Cy, 3830.9 5.9 Pt,
3827.9 5.3 Cd, 3831.9 5.8 Pt.
3829.0 5.0 Cy, 3831.9 5.5 Ie.

184300 NOVA AQUILAE #3—
3830.9 10.6 Pt, 3831.9 10.2 Ie.

185437b CPD 17°8450—
3760.9 10.5 Bl.

190108 R AQUILAE—
3831.9 7.4 Pt.

190926 X LYRAE—
3831.9 8.9 Pt.

190967a U DRACONIS—
3831.9 13.8 Pt.

191033 RY SAGITTARII—
3770.0 9.8 Bl.

191124 TY SAGITTARII—
3761.9 10.5 Bl.

191350 TZ CYGNI—
3831.9 10.9 Pt.

191637 U LYRAE—
3831.9 9.0 Pt.

192928 TY CYGNI—
3831.9 13.8 Pt.

193311 RT AQUILAE—
3831.9 14.0 Pt.

193449 R CYGNI—
3831.9 13.7 Pt.

193509 RV AQUILAE—
3831.9 9.6 Pt.

193972 T PAVONIS—
3760.9 9.4 Bl, 3782.0 8.2 Bl.
3770.0 8.5 Bl,

194048 RT CYGNI—
3791.0 11.2 Ch, 3827.5 7.8 Cd,
3803.5 9.6 Cy, 3829.8 8.0 Ca,
3814.9 8.4 Cy, 3830.7 7.5 Pt,
3816.5 8.5 Ca, 3831.9 8.0 M.
3824.9 8.3 Cy,

194348 TU CYGNI—
3831.9 13.5 Pt.

VARIABLE STAR OBSERVATIONS, January 20 to February 20, 1924—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
194604 X AQUILAE—						
	3831.9	8.8	Pt.			
194632 χ CYGNI—						
	3754.9	5.2	Ha,	3782.9	6.3	Ks,
	3755.9	5.2	Ks,	3782.9	6.0	Kd,
	3756.9	5.3	Ks,	3783.9	6.3	Ks,
	3757.9	5.3	Ks,	3784.9	6.3	Ks,
	3761.9	5.3	Ks,	3784.9	6.1	Kd,
	3764.9	5.4	Ks,	3786.9	6.2	Kd,
	3764.9	5.7	Ha,	3786.9	6.3	Nk,
	3767.9	5.6	Ks,	3787.9	6.4	Nk,
	3771.9	5.9	Ks,	3788.9	6.3	Kd,
	3772.9	5.9	Ks,	3791.0	6.5	Ch,
	3773.9	5.9	Ks,	3792.9	6.4	Kd,
	3776.9	5.8	Ks,	3798.9	6.6	Kd,
	3777.9	6.1	Ks,	3807.5	6.5	Pt,
	3778.9	6.0	Ks,	3816.9	7.2	Ca,
	3779.9	6.1	Ks,	3818.5	7.6	Ch,
	3780.9	6.3	Ks,	3823.9	7.7	Ca,
	3781.9	6.2	Ks,	3831.9	7.8	Pt.
195553 NOVA CYGNI #3—						
	3806.5	11.4	Pt,	3817.5	11.4	Pt,
	3808.5	11.5	Pt,	3825.5	11.7	Cd,
	3810.5	11.3	Pt,	3826.8	11.3	Pt,
	3816.9	11.6	Ca,	3830.5	11.8	Pt.
195849 Z CYGNI—						
	3802.6	12.7	Wf,	3831.9	12.2	M.
	3831.9	12.6	Pt,			
195855 S TELESCOPII—						
	3782.0	12.7	Bl.			
200212 SY AQUILAE—						
	3831.9	9.0	Pt.			
200357 S CYGNI—						
	3818.5	11.0	Ch,	3831.9	11.2	Pt.
200715a S AQUILAE—						
	3831.9	10.7	Pt.			
200715b RW AQUILAE—						
	3831.9	9.2	Pt.			
200747 R TELESCOPII—						
	3760.9	9.6	Bl,	3782.0	10.1	Bl.
	3770.0	9.8	Bl,			
200938 RS CYGNI—						
	3791.0	7.6	Ch,	3815.0	8.2	Cy,
	3792.3	7.7	Au,	3818.5	7.5	Ch,
	3799.2	8.1	Au,	3824.5	7.9	Ly,
	3812.6	7.6	Ly,	3824.9	8.3	Cy,
	3813.6	7.0	Sg,	3831.9	7.3	Pt.
201008 R DELPHINI—						
	3831.9	8.6	Pt,	3831.9	8.5	Ie.
201139 RT SAGITTARII—						
	3760.9	7.5	Bl,	3782.0	8.4	Bl.
	3770.0	7.7	Bl,			
201437b WX CYGNI—						
	3791.0	11.0	Ch,	3831.9	12.2	Pt.
201647 U CYGNI—						
	3771.3	10.2	Au,	3823.8	10.9	Ca,
	3792.3	10.6	Au,	3831.9	9.5	Pt.
	3799.2	10.7	Au,			
202240 U MICROSCOPII—						
	3760.9	8.8	Bl,	3782.0	8.0	Bl.
	3770.0	8.4	Bl,			
202539 RW CYGNI—						
	3792.3	9.3	Au,	3804.2	9.4	Au.
202817 Z DELPHINI—						
	3750.7	8.5	Ml,	3831.9	11.4	Pt.
202946 SZ CYGNI—						
	3806.5	9.5	Pt,	3817.5	8.9	Pt,
	3808.6	9.8	Pt,	3824.5	9.9	Pt,
	3810.5	9.8	Pt,	3830.5	8.7	Pt,
	3815.5	8.8	Pt,	3831.5	8.9	Pt.
202954 ST CYGNI—						
	3831.9	9.5	Pt.			
203226 V VULPECULAE—						
	3831.9	8.8	Pt.			
203429 R MICROSCOPII—						
	3760.9	9.5	Bl,	3782.0	10.0	Bl.
	3770.0	9.3	Bl,			
203816 S DELPHINI—						
	3831.9	11.2	Pt.			
203847 V CYGNI—						
	3795.1	8.7	Ch,	3823.9	8.7	Ca,
	3800.1	8.7	Ch,	3831.9	7.7	Pt.
	3807.0	8.8	Ch,			
204946 RZ CYGNI—						
	3804.5	12.3	Wf,	3831.9	12.6	Pt.
	3824.5	12.4	Wf,			
204954 S INDI—						
	3770.0	13.3	Bl,	3782.0	12.2	Bl.
205923 R VULPECULAE—						
	3831.9	10.2	Pt.			
210129 TW CYGNI—						
	3803.5	10.3	Ie.			
210868 T CEPHEI—						
	3786.0	10.2	Nk,	3806.3	10.2	Au,
	3787.9	9.9	Nk,	3808.6	9.5	Kl,
	3792.3	10.6	Au,	3824.5	9.2	Kl,
	3799.3	10.3	Au,	3825.6	9.0	Ya,
	3800.1	10.0	Ch,	3829.8	8.7	Ca.
212030 S MICROSCOPII—						
	3761.0	8.5	Bl,	3782.0	8.8	Bl.
	3770.0	8.6	Bl,			
212814 Y CAPRICORNI—						
	3761.0	12.8	Bl.			
213244 W CYGNI—						
	3779.9	5.7	Kd,	3792.9	6.2	Kd,
	3782.9	5.7	Kd,	3798.9	6.1	Kd,
	3785.9	5.8	Kd,	3807.9	6.0	Kd.
213678 S CEPHEI—						
	3825.6	8.5	Ya.			
213753 RU CYGNI—						
	3795.1	8.7	Ch.			
213843 SS CYGNI—						
	3784.9	10.0	Nk,	3812.5	11.6	Cd,
	3785.9	10.2	Nk,	3812.5	11.5	Cy,
	3786.9	10.1	Nk,	3812.6	11.5	Ly,
	3787.9	9.8	Nk,	3814.6	11.2	Lv,
	3791.1	9.0	Ch,	3815.5	11.8	Pt,
	3793.1	8.9	Ch,	3816.0	11.7	Ch,
	3795.1	8.6	Ch,	3816.5	11.6	Ie.
	3798.0	8.6	Ch,	3816.5	11.6	Cd,
	3799.5	8.8	Cy,	3816.5	10.9	Ca,
	3800.1	8.6	Ch,	3816.5	11.7	Y,
	3800.5	8.8	Cy,	3817.5	11.7	Pt,

VARIABLE STAR OBSERVATIONS, January 20 to February 20, 1924—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
213843 SS CYGNI—Continued.				
	3801.1	8.7 Ch,	3817.6	11.6 Wf,
	3802.1	8.9 Ch,	3817.7	11.7 Sg,
	3802.5	9.3 Wf,	3818.5	11.2 B,
	3802.5	9.1 B,	3818.6	11.8 Wf,
	3803.0	9.1 Ch,	3821.0	11.6 Ch,
	3803.5	9.7 Cy,	3821.6	11.7 Br,
	3803.5	9.3 Cd,	3823.5	11.8 Cd.
	3803.5	9.2 Ie,	3823.5	11.8 B,
	3803.6	9.3 Br,	3824.5	11.8 Ca,
	3804.1	9.4 Ch,	3824.5	11.7 Wf,
	3804.5	9.7 Wf,	3824.5	11.5 Pt,
	3805.0	9.5 Ch,	3824.5	11.6 Ly,
	3805.5	9.8 Ca,	3824.5	11.3 Kl,
	3806.5	10.9 Pt,	3824.6	11.6 Br,
	3807.0	9.8 Ch,	3824.9	10.9 Cy,
	3807.5	11.0 Pt,	3825.5	11.6 Ie,
	3808.5	10.8 Pt,	3826.5	11.8 Kl,
	3808.5	10.7 Cd,	3827.5	11.6 Cd,
	3808.6	10.9 Kl,	3827.5	11.5 Ca,
	3809.6	11.2 Br,	3827.5	11.7 Y,
	3810.5	11.3 Ly,	3829.5	11.2 Ca,
	3810.5	11.4 Pt,	3829.5	11.3 Ie,
	3810.5	11.0 Ca,	3830.5	11.7 Pt,
	3811.5	11.4 Pt,	3831.5	11.7 Pt,
	3811.6	11.7 Kl,	3831.5	11.5 Ie,
	3812.1	11.8 Ch,	3832.5	11.7 Ie,
	3812.5	11.5 Ie,	3834.5	10.6 Cd.
213937 RV CYGNI—				
	3771.2	8.3 Au,	3804.3	8.5 Au,
	3771.3	8.5 Au,	3811.5	6.5 Pt.
	3785.3	8.2 Au,		
214247 R GRUIS—				
	3761.0	9.5 Bl,	3782.0	10.2 Bl.
	3770.0	10.2 Bl,		
215934 RT PEGASI—				
	3811.5	10.5 Pt,	3817.7	10.5 Sg.
220133b RZ PEGASI—				
	3811.5	8.4 Pt.		
220613 Y PEGASI—				
	3811.5	10.5 Pt.		
220714 RS PEGASI—				
	3811.5	12.0 Pt.		
222439 S LACERTAE—				
	3811.5	12.5 Pt,	3812.5	12.9 Ie.
222867 R INDI—				
	3782.0	13.5 Bl.		
223841 R LACERTAE—				
	3795.1	9.9 Ch,	3814.6	9.6 Lv.
	3811.5	9.2 Pt,		
224354 U LACERTAE—				
	3792.4	9.1 Au,	3804.3	9.1 Au.
224455 V LACERTAE—				
	3771.3	9.3 Au,	3804.2	8.5 Au.
225914 RW PEGASI—				
	3811.5	9.5 Pt,	3815.7	8.5 Sg.
230110 R PEGASI—				
	3811.5	11.6 Pt.	3825.5	11.0 Cd,
	3812.5	10.6 Cd,	3829.5	10.8 Cd.
	3812.5	12.4 Ie,		
230759 V CASSIOPEIAE—				
	3776.3	7.8 Au,	3811.5	8.3 Pt,
	3784.2	7.9 Au,	3812.6	9.3 Cy,
	3784.9	8.5 Nk,	3821.1	9.3 Ch,
	3785.9	8.5 Nk,	3823.6	9.7 Ca,
	3787.9	8.4 Nk,	3826.6	9.5 Cy,
	3792.3	8.3 Au,	3829.6	9.5 B,
	3803.5	9.0 Cy,	3829.7	9.6 Cy.
	3806.3	8.9 Au,		
231425 W PEGASI—				
	3812.1	9.0 Ch,	3830.6	9.5 Lv.
231508 S PEGASI—				
	3811.5	9.9 Pt.		
232848 Z ANDROMEDAE—				
	3811.5	9.9 Pt,	3821.1	9.8 Ch.
233335 ST ANDROMEDAE—				
	3802.1	9.2 Ch,	3826.6	9.2 Sg.
	3811.5	8.7 Pt,		
233815 R AQUARII—				
	3811.5	7.5 Pt,	3812.0	7.5 Ch.
235209 V CETI—				
	3771.2	9.3 Au,	3806.3	6.8 Au.
	3799.3	7.3 Au,		
235350 R CASSIOPEIAE—				
	3803.5	7.4 Cy,	3824.6	6.3 Ly,
	3808.6	6.5 Ca,	3826.6	6.4 Cy,
	3812.6	6.5 Ly,	3829.5	6.3 Ly,
	3812.6	6.5 Cy,	3829.6	6.4 B,
	3813.6	6.0 Lv,	3831.5	6.5 Ly,
	3816.6	6.1 Ca,	3832.6	6.3 Ca,
	3823.6	6.2 Ca,	3834.5	6.3 Ly.
235525 Z PEGASI—				
	3811.5	8.5 Pt.		
235939 SV ANDROMEDAE—				
	3818.5	13.4 B.		

Total Observations: 1,498. Stars Observed: 288. Observers: 31.

The following have been elected to annual membership in the Association:

Rev. W. M. Kearons, Fall River, Mass.
Dr. L. P. Rippy, Wentworth, N. C.
Mr. L. B. Bayley, Khartoum, Africa.

The Chart Committee has commenced work on the "A" type charts and has ready for distribution a map of the region of *o* Ceti, Mira. These "A" charts contain only stars brighter than 7.5 and are intended for use only when the variables are bright enough to be observed with a very small telescope, field glass,

or unaided eye, and should fill a long-felt want for the members who do not possess telescopes of 3-inches aperture or more. Members requiring these "A" type charts should make application directly to Mr. D. B. Pickering, 171 South Burnett Street, East Orange, N. J., stating what instrument, if any, they have for observing purposes. Other charts will be issued as they are completed.

A very commendable blue print chart, 20 x 20, of the northern heavens has been prepared by Mr. Brocchi, a member of our chart committee, and contains stars brighter than the magnitude 5.5, plotted for the epoch of 1930, positions from Boss's Catalogue and magnitudes on the Harvard scale. It is a finely executed map and copies may be obtained directly from Mr. D. F. Brocchi, 4331 Thackery Place, Seattle, Washington, on receipt of price, fifty cents. This chart should prove useful to our observers.

The following observers contributed to this report: Messrs. Allen "Al", Aurino "Au", Baldwin "Bl", Bouton "B", Brocchi "Br", Carr "Ca", Chandler "Cd", Chandra "Ch", Cilley "Cy", Miss Clough "Cg", Gaebler "Gb", Hama "Ha", Miss Holmes "Hm", Iedema "Ie", Inglis "I", Kasai "Ks", Kanda "Kd", Kleis "Kl", Leavenworth "Lv", Lefever "Lf", Mrs. Lytle "Ly", McAteer "M", Miyajima "My", Murata "Mt", Nakamura "Nk", Parkhurst "Pa", Peltier "Pt", Skaggs "Sg", Waterfield "Wf", Yalden "Ya", and Miss Young "Y".

HOWARD O. EATON, Recording Secretary.

COMMUNICATIONS.

Venus Halo.—The following may be of interest to the readers of POPULAR ASTRONOMY: While observing Venus the night of February 11, 1924, at about 7:15 p. m. I noticed a halo of light encircling the planet and about 1° away from it on all sides. The halo was of the same color as the planet, but very much fainter. It remained of practically the same size and color during the six minutes I observed it, and was a naked eye object.

Venus was then between 23° and 20° above the horizon. The moon was about one day from first quarter, and had no halo around it.

49 Arlington St., Worcester, Mass. SAMUEL CRAMER.

The Intercalary Week.—I would like to call your attention to some of the defects of a calendar based upon an intercalary week.

The Gregorian Calendar was invented to stabilize the date of the vernal equinox, which it has done within the limits of one day. This is the least possible unit of time in a calendar system. Now if an intercalary week is introduced the date of the vernal equinox would shift back and forth through the limits of a whole week. One year it would occur on the 18th of March and after a week was intercalated it would happen on the 25th of the month.

The statistical side of business operations is receiving an increasing amount of attention nowadays. In order to eliminate seasonal variations it is necessary to compare the figures of one month with those of the same month the year before. But when an intercalary week is sandwiched in between these two months, and supposing the months were to be 28 days long, we would have a case of comparing 28 days of business in April of one year with 21 days of April and 7 days of May of the year before as referred to the seasons. Sometimes, of course, the vagaries of the seasons would be such as to neutralize this

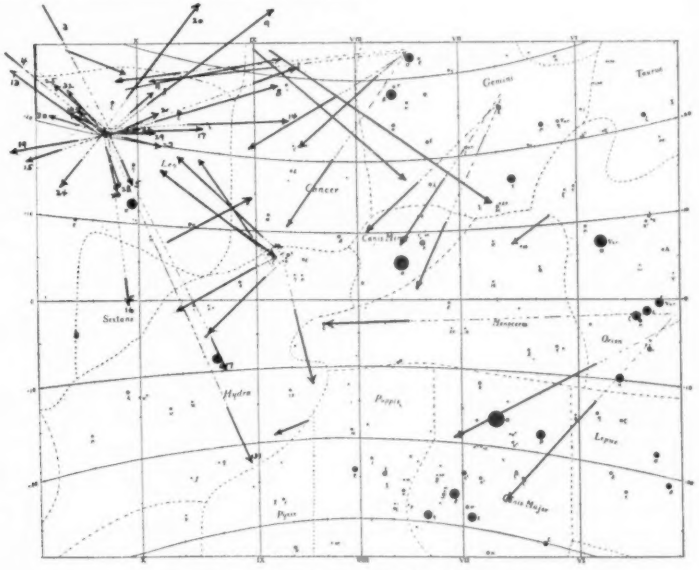
but at other times it would be doubled. Also in comparing one year with another, one would have to make an allowance of almost two per cent in the case of a leap year; it being that much longer than an ordinary year.

Would we not rather keep our Gregorian Calendar, which has not yet been outgrown, than to have the days of the month come on the same days of the week at the price of an intercalary week?

RALPH LEFEVER.

Strang, Nebraska, March 18, 1924.

The Leonids.—Cloudy weather persisted from November 12 to midnight of the 17th, when it cleared off fine and warm. The slight Cirro-Stratus haze disappeared at 14:45. The hourly rate was 22, and the radiant sharply defined at Gamma Leonis; there was an unusual number of short, rather bright Leonids close to Gamma, enabling one to get a very precise radiant. The results show that there is a considerable increase over the last few years and it is to be supposed that each year from now on will give more and more active displays until the maximum in 1933 or 1934. The 19th was also beautifully clear and warm and enough Leonids were observed to get the radiant closely. It seems certain that the radiant shifts slowly east by east-northeast, as this was clearly indicated both in 1922 and this year.



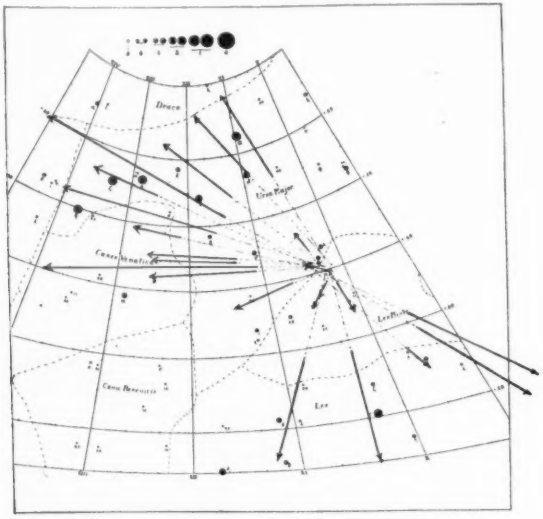
Leonids, November 17, 1923.

The Leo Minorids were especially active with an hourly rate of 30 or more. They were noticeably slow and mostly very long, with some very bright individuals. There was also a radiant near the Head of Hydra which yielded some good ones. Also a number radiated from Alpha Gemini and the observer has noticed that this seems to be a continuation of many observed both in October

and early in November. Three Orionids were noticed and there was still another radiant active near 75° +23°. The tabulated results are as follows:

	h			
Nov. 17, 1923	14:30	21 white,	11 red or yellow;	5 left trails.
Nov. 19, 1923	15:00	5 white,	3 red ;	1 trail

	Radiant				Radiant	
Nov. 17	153°	0′	+21°	Leo Minorids	153° 45′	+40°
				Hydrids	132° 00′	— 7°
Nov. 19	153°	27′	+20°	Geminids	112° 30′	+23°
				Geminids	100° 48′	+27°



Leo Minorids, November 17, 19, 1923.

Magnitudes, Leonids.

	0	1	2	3	4	5	6	Totals
Nov. 17	4	0	7	7	2	10	2	32
Nov. 19	0	0	1	1	2	3	2	9

The Leonids were rather swift when near the point of emanation, and very swift when some distance away.

R. M. Dole.

East Lansing, Michigan.

The Meteors of March 8, 1924.—At 10:03 P. M., March 8, 1924, I received the pleasantest surprise of my young astronomical career. I was returning home from my father's store, and traveling south when I saw a vivid red meteor come whirling along the eastern horizon and traveling south. I instantly saw that it was no ordinary meteor. It seemed to writhe like a thing alive, rising and falling, darted and swerved, and displayed singular fluctuations in light. While traveling anywhere from 5° to 15° it would change as much as 3 or 4 magnitudes. After watching the meteor vanish at about 10° east of southeast, I turned my head to the north from whence it had come. Several houses were in the way, so that I could not see lower than 30° altitude. As I looked up over

the top of the houses, I thought the roof was on fire but suddenly realized that I was looking at a meteor shower and not a fire. Meteor after meteor came soaring into view, each one passing through the same convulsions as the first. Truly, it was an awe-inspiring sight. The meteors flew so fast that I lost all track of them. I may have seen any number between 15 and 40. They seemed to come from the region of Polaris.

The shower lasted, that is I observed it, for about 15 seconds. It may have been under way before I first saw it.

SAMUEL CRAMER.

49 Arlington St., Worcester, Mass., March 9, 1924.

GENERAL NOTES

IN MEMORIAM.

It is with a feeling of great sadness and a deep sense of personal loss that we announce to our readers the death of Mrs. H. C. Wilson, the wife of the senior Editor of POPULAR ASTRONOMY.

Mrs. Wilson died on Friday evening, March 14, at St. Luke's Hospital in St. Paul, after an illness of one week, following an operation. No one, not even the physicians and nurses in attendance, knew that Mrs. Wilson's condition was critical until late on Friday afternoon, and the end came suddenly and almost without warning.

Mrs. Wilson frequently accompanied Professor Wilson to the meetings of the American Astronomical Society and many of the members of the Society became acquainted with her in that way. Professor and Mrs. Wilson went to California last summer and were on Catalina Island at the time of the total eclipse on September 10.

Mrs. Wilson was highly esteemed by a host of friends and beloved by all who knew her more intimately. Her cheerfulness and optimism were an inspiration to all who came in contact with her.

Her loss is keenly felt by the College and the community of which she was a part for many years.

E. A. FATH.
C. H. GINGRICH.

M. Stephan, honorary director of the Marseilles Observatory, and correspondent of the section of astronomy of the Paris Academy of Sciences, has died at the age of eighty-seven years. (*Science*, Feb. 22.)

The Gold Medal of the Royal Astronomical Society has been awarded to Professor A. S. Eddington, for his work on star-streaming, on the internal constitution of a star and on generalized relativity. (*Science*, Feb. 22.)

Mr. William Gaertner, president of the Gaertner Scientific Corporation, 1201 Wrightwood Avenue, Chicago, Illinois, has been awarded the Howard N. Potts gold medal by the Franklin Institute, acting through its committee of science and arts.

This medal was awarded to Mr. Gaertner "in consideration of his notable

achievement as a designer and maker of scientific instruments, materially contributing to the success of the research in physical science."

Mr. Gaertner, for twenty-eight years, has been the sole proprietor of Wm. Gaertner & Company, makers of scientific instruments, formerly located at 5345 Lake Park Avenue, and at present he is the head of The Gaertner Scientific Corporation. He is recognized as one of the foremost scientific instrument makers in the United States, and is given credit for having emancipated American educational and scientific institutions from their dependence on foreign-made scientific instruments.

American Astronomical Society.—The next meeting of the Society will be held at Dartmouth College, Hanover, New Hampshire, from August 3 to 6, 1924. Sessions for papers will begin on August 4 and extend through August 6. It is expected that a number of English astronomers will be at this meeting en route to the meeting of the British Association for the Advancement of Science, which will be held in Toronto from August 6 to 13.

JOEL STEBBINS, Secretary.

Angular Dimensions of the Magellanic Clouds. — In the H.C.O. Bulletin 796 Dr. Harlow Shapley, director of the Harvard College Observatory, gives the results of measures of the angular diameters of the two great stellar clusters in the southern hemisphere of the sky known as the Magellanic Clouds. The diameters in four directions are:

Direction	Large Cloud	Small Cloud
° °	°	°
0 —180	7.2	3.4
45 —225	6.8	4.1
90 —270	7.0	4.0
135 —315	7.7	3.0
Average	7.2	3.6

Dr. Shapley says that the Large Cloud is essentially circular, and the Small Cloud more nearly so than generally supposed. There is little or no suggestion in Bailey's photograph (in 1909) of spiral structure in either cloud, the various condensations being irregularly distributed.

Dr. Shapley gives provisional estimates of the distances as 35,000 parsecs for the Large Cloud and 25,000 parsecs for the Small Cloud, and from these the resulting linear diameters would be approximately 14,000 and 5,000 light years.

The 20-ft. Telescope of the Herschels.—In the November number of *Monthly Notices* of the Royal Astronomical Society the Rev. C. D. P. Davies gives an interesting note on this famous telescope. It appears that three mirrors of speculum metal had been made for the instrument, of slightly different focal lengths and 18¾ inches in diameter. This instrument was the one taken to the Cape of Good Hope by Sir John Herschel for the purpose of completing the "star-gauges" in the southern hemisphere. Mirror No. III was made by the two Herschels, father and son, working together in the grinding and figuring. The mirror was repolished a number of times while in use at the Cape. Rev. Davies had the opportunity of testing the mirror by the Foucault method and it proves to be of a very high quality, considering the fact that the Foucault method was unknown to the Herschels, who were obliged to carry out all tests of figure at the principal focus. The focal length of the mirror measured exactly 20 feet. It appears that upon Sir John Herschel's return from the Cape in May, 1838, the

telescope was not remounted and there is no record of its having been used since that time.

Metals in Astronomic Space.— Throughout the vast supposed "emptiness" of space there are clouds of extremely rare vapors of the metals, calcium and sodium. This new theory has been presented to astronomers by Dr. J. S. Plaskett, director of the Dominion Astrophysical Observatory, Victoria, B. C., who recently announced his conclusions and offered his data to the Royal Astronomical Society in London.

For a long time it has been known that some of the very hottest stars, when their light was analyzed in the spectroscope, showed the presence of calcium, that did not belong to the stars themselves. For the spectroscope revealed the fact that while the stars often had considerable velocities, the calcium seemed to be almost at rest. Moreover, this calcium persisted in appearing in just those stars where theories of stellar composition indicate it should not.

In explanation, some astronomers suggested that the stars are surrounded by an envelope of calcium gas belonging to the stars themselves. Others proposed that the calcium clouds were lying between us and the stars. The observations, however, were so meager and contradictory that no definite conclusions could be arrived at.

Dr. Plaskett's observations indicate that although extremely rare clouds of calcium and sodium vapor are lying around in space everywhere, they are only noticed in the neighborhood of stars. This is because, surrounding these stars completely, they intercept some of their light. The clouds appear to be perfectly at rest in space, acting as a sort of misty envelope of the stars, a space-fog, which possibly can condense in spots and give rise to those peculiar dark nebulae which have long puzzled astronomers. (*Science Service.*)

A Telescope for South Africa.— Professor William J. Hussey, director of the University of Michigan observatory, at present in Africa, has found a location near Johannesburg for the new 27-inch telescope made possible largely through the gift of Robert P. Lamont, of Chicago.

The expedition to Africa marks the end of a 20-year search by Professor Hussey of the southern hemisphere to discover the best site for the telescope with which to carry on his work on double stars. Australia was visited in 1903 and South America in 1911. While on the latter trip Professor Hussey spent several years in Argentina, where he was director of La Plata Observatory.

Africa was the only continent left on which to find a site for the telescope. He has picked out one of the battle fields of the Boer war as a site for the new telescope.

In 1911 Mr. Lamont donated to the university sufficient funds to purchase a lens for the observatory. The order for the objective was placed with a firm in the east which has made the lenses for the Lick and Yerkes observatories. However, it was found that they could not secure suitable glass for the work, so an European firm was given the order.

With the world war coming on, this firm refused to take the risk of shipping the huge glass to this country and the contract was let to an American firm. But in 1921 the order was again cancelled and given to an European dealer, who was able to obtain the needed materials. The discs arrived in America a year ago and the work of polishing them began.

It is hoped that the new telescope will be ready by next fall. The lens probably will be ready by that time, and only the lower end of the tube and the

other sections remain to be finished. This can be completed in a very short time.

Work on the lens was threatened for a time last fall when J. B. McDowell, who was putting the finishing touches to it at his factory in Pittsburgh, committed suicide. It is thought that the extreme nervous strain of the work proved too severe for McDowell, as he had reached the point where he alternately polished for three minutes and waited 60 minutes for the temperature of the glass raised by the friction of polishing to go down to normal. An associate of McDowell has taken charge of completing the work. (*Science Service.*)

Some New Books.—Littrow's Atlas des gest. Himmels, 3rd edit., pocket size; Am. Fernrohr, F. Becker, 83 pp.; Kleine Himmelskunde, Prof. J. Plassmann, 136 pp.

We have just received these three books from the publishers, Ferd. Duemmler Co. of Berlin and Bonn. The first contains a well-written introduction by Prof. Plassmann which is designed to aid the beginner in becoming acquainted with constellations and planets, a table giving the positions of the sun and planets visible to the unaided eye at 5-day intervals for 1924 and 1925, a series of star charts for the entire sky, the star fields of the Pleiades, Hyades and Praesepe, and a chart of the moon. The little volume is convenient and well arranged.

The second of these books will be of value to those having small telescopes. The first few pages are devoted to a table giving the names, magnitudes, colors and spectral types of stars down to the third magnitude; then comes a list of double and multiple stars grouped by constellations, their positions for 1900, a brief description of each and the number of the pair in Burnham's Catalog; the third part contains a list of the brighter nebulae and clusters with their positions for 1900, the N. G. C. number and a brief description of each object; the fourth part deals with variable stars and, in the opinion of the reviewer, is the most valuable portion of the book. It gives a selected list of the brighter variable stars, charts for most of the fields, magnitudes of comparison stars, the range of variation, the elements according to Hartwig, brief notes and the light curves of many of the better known variables.

The last of the three is a short exposition of descriptive astronomy. Seven-eighths of the book is devoted to a consideration of the solar system. The planet Mars is given special consideration. The author rejects *in toto* the theory that the "canals" are in any sense artificial. The book has a number of good illustrations and a 2-page map of the moon. We hope that at some future time the author will expand the portion dealing with stars and nebulae and thus cover the field of astronomy in a more "balanced" fashion.

Manual of Laboratory Astronomy, Harlan True Stetson, Ph. D., Eastern Science Supply Co., Boston, 1923.

This manual contains a well-selected series of problems and exercises for the use of classes in laboratory astronomy which can be undertaken without much elaborate equipment. These problems include the construction of star charts; height of atmosphere from meteor observations; sun's diurnal path in various latitudes; use of celestial globe; seasons; sidereal, apparent and mean solar time; sun-dial; moon's motions; moon's topography; graphical method of calculating a lunar eclipse; motions of planets; meteor radiant; solar rotation; principles of spectroscopy; stellar distances; variable stars; stellar spectra and the astronomical telescope.

The instructions are given clearly and references to standard texts are included for each exercise. The use of a binder which allows additional sheets to be inserted is of real value. The manual can be highly recommended.